MACHINE DESIGN

Replacement of Materials May Spell Invention

By George V. Woodling

MACHINE designers may create an invention by the novel use of materials and not realize that they have produced a patentable idea. It is well recognized, as a general rule, that the substitution of one material for another is not invention, but there are certain exceptions. Thus one is not aware ordinarily that it is invention to substitute a light aluminum alloy for cast iron, yet such a change was held to be patentable in the Horgan shoe-clicking machine, *Fig.* 1, used to cut shoe uppers from a number of plies of leather.

As illustrated, the machine has a die bed to carry the stock and a laterally swinging

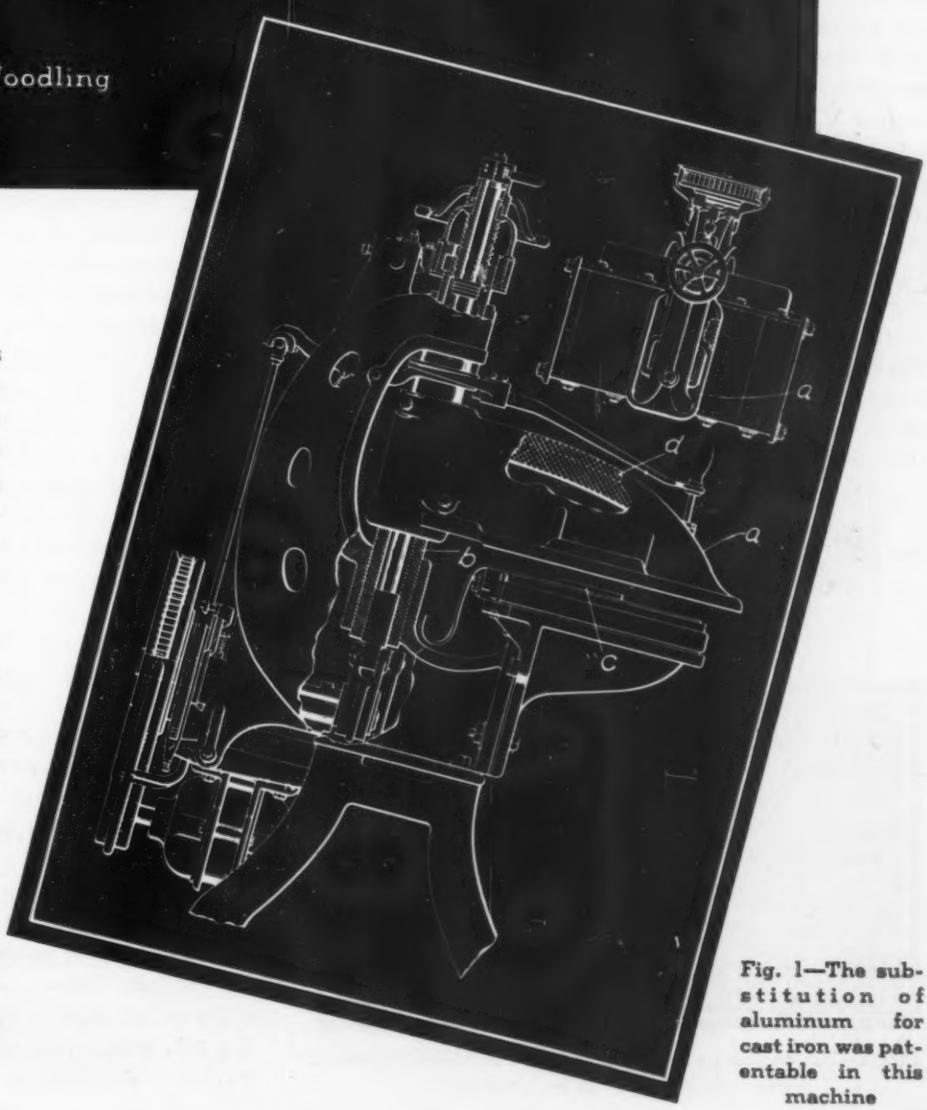

Fig. 1—The substitution of aluminum for cast iron was patentable in this machine

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hammer or pressure arm *a* supported at one end on a post *b*. It is moved manually into a position over a steel cutting die *c* placed on the stock. When the operator has swung the arm into position over the die, he touches a tripping mechanism causing the hammer arm to drive the steel die through the work. The arm is then raised to its initial position after which the operator swings the arm back out of the way so as to have unobstructed access to the work for the proper placing of the die for the next cutting operation. The swinging arm is a ram or hammer and strikes the steel die with great force. Therefore it was considered essential by expert engineers prior to the Horgan machine that the hammer be made of heavy cast iron, weighing approximately 519 pounds to withstand the severe pounding.

During a day's work, it was estimated that the operator swung the heavy arm back and forth about 4000 times. This was extremely tiring and burdensome. Horgan eased the task by substituting light aluminum alloy for cast iron and reduced the weight of the swinging hammer arm to 173 pounds. In the illustration the aluminum alloy is identified by the letter *d*.

A claim of Horgan's patent reads as follows

"A pressure member for clicking machines composed of an aluminum alloy having a high aluminum content."

In an infringement suit on the patent the defendant argued that the use of aluminum instead of cast iron was a mere substitution of material and therefore did not rise to the dignity of invention. The court found that at approximately the time Horgan made his invention, other skilled engineers in the field were at work endeavoring to overcome this arduous task of swinging the heavy presser arm. These engineers discouraged Horgan's suggestion that the material be made lighter, but notwithstanding their disparaging comments Horgan continued his experiments with aluminum alloy until he developed a successful presser arm which would withstand the heavy hammering. In view of the above facts the court was definitely of the opinion that the substitution of an aluminum alloy for cast iron in the Horgan machine was patentable and, accordingly, sustained the patent.

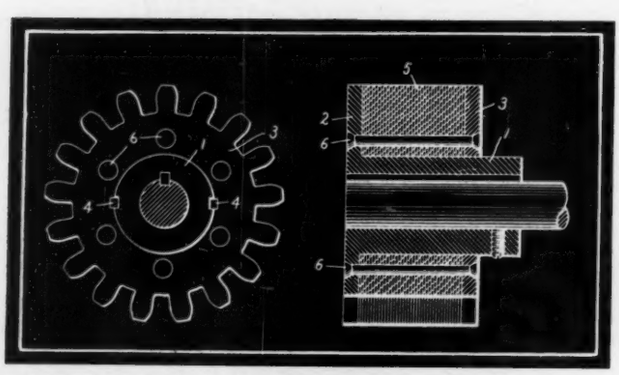

Fig. 2—Use of fibrous material in place of rubber in silent gear was held not to be invention

GEO. V. WOODLING

PREVIOUS announcements of the invaluable book on patents by George V. Woodling, author of the accompanying article, have brought immediate response from readers in the form of inquiries and orders. The book, "INVENTIONS AND THEIR PROTECTION" is now off the press. Interested engineers will find complete details covering contents, etc., on pages 54 and 79 of this issue

This example stresses the importance to engineers of keeping on the lookout for the creation of a *new function*, when a substitution is made in materials in designing new machinery. The failure to observe a new and unexpected result brought about by a change in materials may mean the loss of a valuable patent. The new result must be something more than a reduction in cost of manufacture or an improvement in the appearance of the device. The new function must go to the *mode of operation* of the device.

Thus, it was held that the development of noiseless gears, *Fig.* 2, having a self-sustaining body portion of fibrous material and Bakelite instead of hard rubber was not invention. The court was of the opinion that there was no good reason why a skilled mechanic would have doubted that Bakelite had as favorable properties in the direction stated as hard rubber.

A good test for invention is whether or not an unsuccessful device is made successful by the substitution of new materials. If the change makes an unsuccessful device successful, then this is strong evidence of patentability. A good example illustrating this point involved an indicating drum for a computing scale which would not weigh accurately be-

cause of its heavy weight. An inventor by the name of Smith solved the problem by reducing the weight of the drum. He used a thin aluminum skeleton frame covered by a thin sheet of paper pasted to the skeleton frame, thereby giving a flyweight construction which did not interfere with the weighing operation. In a suit thereon, Smith's patent was held valid.

The selection of materials for the spark plug, shown in *Fig.* 3, for gas engines presents an interesting case of patentable invention. The materials which entered the new spark plug were selected to give perfect operation whether the engine was idling or running fast. When an engine is idling or running at slow speeds, the heat conducted from the "sparking point" must not be too sudden as the rapid cooling will cause the "sparking point" to become fouled, interfering with the ignition. On the other hand when the engine is running fast the "sparking point" will overheat, due to the frequent explosions. This causes premature firing — backfire — unless the "sparking point" can conduct the heat away quickly enough to remain relatively cool. The optimum condition therefore is to retain the heat in the "sparking point" at low speeds and to get rid of the heat at high speeds.

Three Conditions Met by New Materials

To accomplish this the inventor found that the shank *a* must be heat conducting, the head *b* heat resisting, and the sparking point *c* nonerosive. Therefore, the shank *a* was made of carbon steel, a heat-conducting metal which would withstand the heat and strains, and the head *b* was made of chromium steel, a heat resistant metal which would not scale or lose its shape when subjected to combustion conditions. The sparking point *c* was made of manganese nickel alloy,

In a suit for patent infringement the defendant contended that the supposed invention was no more than a substitution of familiar materials, therefore not patentable. The court found, however, that the selection of the materials, though each was old in itself, produced a patentable unit, and that it did not matter whether or not the selected elements were old in themselves. The gist of the invention was the act of selection of the materials to form a patentable combination which was beyond the capacity of commonplace imagination.

The court pointed out that all devices may be made up of the same elements: i.e., rods, pawls, pitmans, journals, toggles, gears, cams and the like and that though these elements are capable of infinite combinations the selection of that group which proves serviceable to a given need may require a high degree of originality.

Another example where the proper selection of materials turned failure into success was the substitution of a chromium-nickel alloy for ineffective materials used in electrical resistance elements. The change of material increased the life of resistance elements for toasters, heaters, electric irons and other appliances. Elements subjected to heats from 800 to 1000 degrees Fahr., now last about 150 times as long as previously. For 11 years the use of chromium-nickel alloy for resistance elements was not discovered and it might yet be hidden had not the inventor found it and made it public. The inventor was entitled to a patent for the services he rendered in rescuing an alloy from obscurity and placing it in the forefront of an industrial application.

The patent was upheld by the court upon the ground that the substitution of material produced such an advance upon the prior art as to turn failure into unquestioned success.

Substitution of tungsten for carbon in a lamp filament was held to be invention of a high order. Tungsten is an elementary metal and was known long before Edison invented the electric lamp. The problem with which inventors were grappling was to discover a metal capable of practical use from the commercial standpoint which would have the attributes necessary for the filament of an incandescent electric lamp. Scientists had experimented with many methods and materials and although tungsten was thus well known, its properties had not been fully discovered and understood until the inventors, Just and Hanaman, rescued it from obscurity.

It must not be inferred from the above examples that the substitution of materials amounts to invention

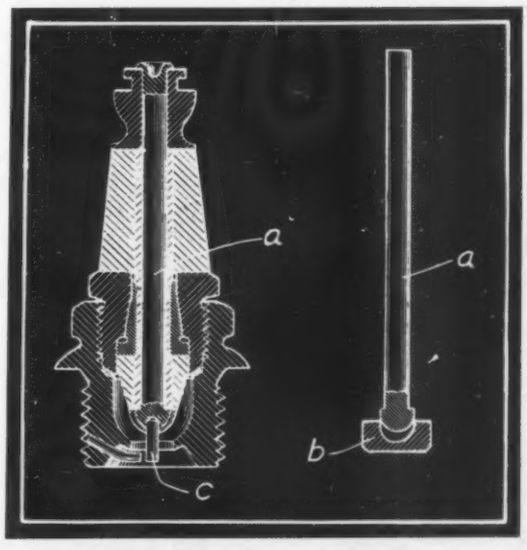

Fig. 3—Refinement of common spark plug by use of new materials was patentable idea

in every case. This inference is not true. Each case must be determined in the light of the surrounding circumstances. If there is no new and unexpected result produced by a change in material, it is not patentable.

Scanning THE FIELD FOR Ideas

DESIGNED primarily for use with fuel, lubricating and heavy crude oils, the unique displacement pump shown in *Fig.* 1, which is built by the De Laval Steam Turbine Co., is capable of operating at standard electric motor and even at steam turbine speeds where capacity demands warrant such high speeds.

This pump is a good example of what can be done with gears of special design. If the illustration be examined closely, it will be seen that the central or power rotor and the two meshing sealing rotors, are what might be described as single tooth herringbone gears, a long single tooth being in effect "wound" in several turns around a central core.

The convex tooth on the power rotor meshes with the concave teeth in the sealing rotors. This establishes what amounts to a fluid-tight closure between the rotors. Contacts between the rotors themselves and between the rotors and their sleeves, provide ample radial bearing surfaces thus obviating the necessity for separate bearings. The double opposed rotors give hydraulic balance axially and thrust bearings are not required.

Liquid upon entering the inlet, which is at the top of the pump, divides and flows to the ends of the rotors. There it is taken up by them and is propelled as by a continuously acting piston to the discharge chamber surrounding the center of the rotors. There are no valves and the flow of oil is extremely smooth.

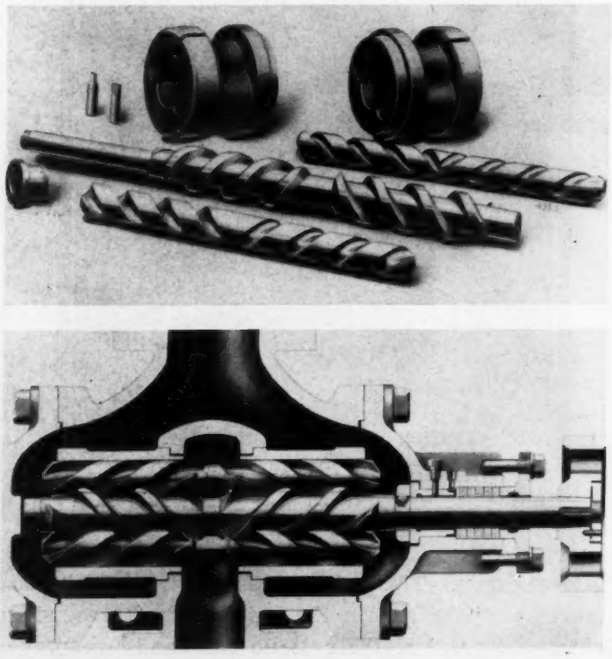

Fig. 1—Smooth, high pressure pumping or hydraulic motor action is attained by unique type of gearing

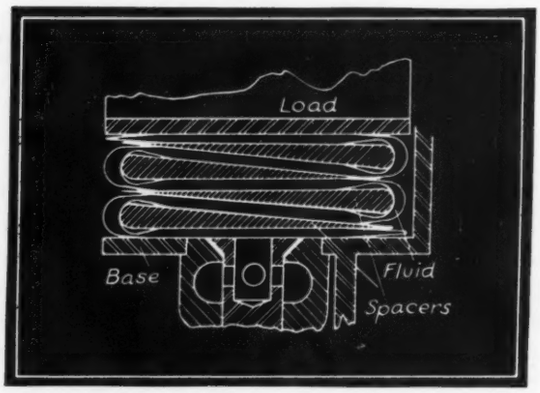

Fig. 2—Heavy localized pressure is developed by forcing liquid or air into a folded flat tube

Diaphragm Multiplies Pressure

MULTI-STAGE diaphragms, such as that of five stages depicted in section in *Fig.* 2 above, providing as they do localized high mechanical pressure from comparatively low line pressure, offer interesting possibilities to designers. The type of diaphragm shown was developed originally by Lindeman Devices, Inc. for actuating radial shoe automotive brakes and is now being furnished for other actuation and control purposes such as of clutches, holding fixtures, damper adjusters, lifting jacks and door openers.

The diaphragm is made up of two strips of metal welded pressure-tight along their edges—the assembly, which really is a flattened tube—then being folded into as many alternating "crimps" as there are stages re-

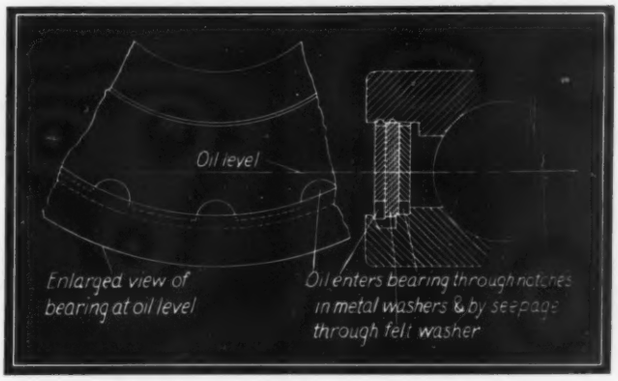
Oil level
Enlarged view of bearing at oil level
Oil enters bearing through notches in metal washers & by seepage through felt washer

Fig. 3—Ball bearings for high speed electric motors have oil level control and trap to catch spray and vapor

quired. It will be noted that extra space is provided at the bends. These bulges, which must be formed into the diaphragm during the course of its fabrication, permit free passage of the pressure medium.

Fluid—or in some cases air—from a pressure line is introduced into this flattened tube. Pressure is spread uniformly over the entire internal area of the tube and tends to open it up into the condition shown in the sketch—thereby effecting endwise motion. The solid wedge-shaped spacers which can be seen in the sketch are introduced between the folds of the diaphragm to assure positive transmission from stage to stage.

In practice the movement obtained from each stage is equivalent to about twice the thickness of the diaphragm metal. Any number of stages from 2 to 100 are practical and total travel of 6 inches is possible.

Felt Washer Traps Oil Vapor

WHILE the majority of ball bearings used in electric motors can be lubricated successfully with grease, there are some cases—especially those involving high speeds—where use of oil is required. In such cases prevention of leakage is the big problem.

To meet this situation the design shown in *Fig.* 3 at the top of this column has been evolved by Westinghouse engineers. Rolling elements in a bearing of this type dip into the oil in the reservoir only as they reach the lowest point of their travel. This affords perfect lubrication without developing oil spray or oil vapor within that part of the housing external to the bearing proper.

Oil passes from the main reservoir to the interior of this bearing through a series of notches in disk-shaped metal enclosing washers which have sandwiched between them a thin felt washer. While the liquid oil can filter inward through this felt, the unavoidable spray and vapor whipped up by the balls is caught by the felt and retained by capillary action, settling back into the oil bath as liquid oil.

Level of oil in the reservoir is maintained approximately on the center line of the lowest ball in the bearing. This is made possible by a filling and overflow gage attached to and communicating with the interior of the housing. The upper surface of this gage is located at the required level, thus a full gage is evidence of a correct amount of oil in the housing. Additional oil is required only after long intervals.

Sweeper Handle "Swallows" Cord

AUTOMATIC control and neat "inside storing" of cord of a vacuum cleaner is successfully accomplished by the fully inclosed spring-driven device which is shown below in *Fig.* 4 in connection with one of the latest Singer machines. This automatic reel, a development by the Vacuum Cleaner Corp. of America, is housed in a stamped steel or aluminum case which is integral with the handle. This case and handle assembly can be styled to suit various makes.

The reel holds cord sufficient to allow cleaning range of 25 feet in any direction from an electrical outlet. In attaching the cleaner, only sufficient cord is pulled out of the handle to allow plugging in. Then as the machine is pushed extra cord draws out as needed.

To rewind either wholly or in part, the "trigger loop" at the hand grip is pulled by the index finger of the operator. This causes the winding spring to go into action, thus drawing unneeded cord back into the handle. The inlet bushing is designed so that it straightens out the cord as it feeds through. When a loop of cord gets in the way of the cleaner, a quick pull on the trigger loop instantly flicks it out of the way. Incidentally the device will "swallow" the full length of the cord in 3 seconds.

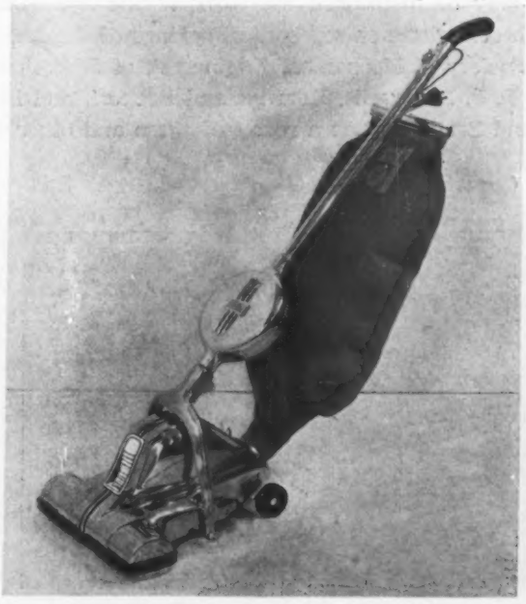

Fig. 4—Automatic reel feeds out vacuum cleaner cord and rewinds it in a casing in the handle

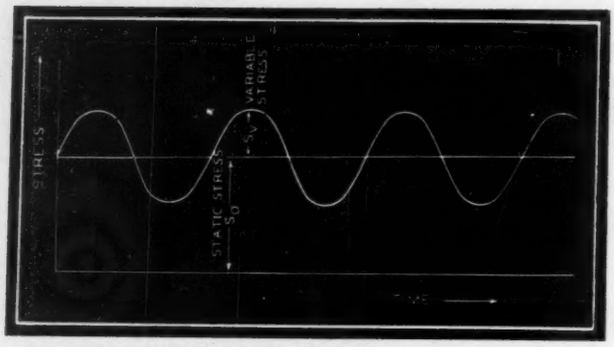

Fig. 1—Stress cycle is plotted with variable stress superimposed on a static stress

General Consid e

Mechanical S

Methods for Determin in

By A. M. Wahl

IMPORTANCE of proper spring design cannot be overestimated since the successful operation of complicated machinery often vitally depends upon the proper functioning of springs, which in themselves may represent only a negligible fraction of the total machine cost. The object of this series of articles is to present to the designer some of the fundamentals underlying the design of, and choice of working stress in, mechanical springs with particular reference to the important helical compression and tension spring, and in addition to present some of the latest results of research on springs in a convenient form.

Since the original series of spring articles was published in MACHINE DESIGN, a considerable amount of research on springs and spring materials has been carried out, and much fatigue test data on stress concentration effects and on the effect of combined static and variable stresses (such as usually occur in practical springs) have become available. Among the more important investigations of springs and spring materials may be mentioned the work of the special research committee on mechanical springs of the American Society of Mechanical Engineers[1], of J. B. Johnson[2], F. P. Zimmerli[3], Hankins and Becker[4], and Batson and Bradley[5]. As a result of these and other investigations mentioned later, much progress has been made toward placing spring design on a more rational basis, particularly for the more common spring materials. In spite of these studies, however, it is still necessary for the designer to exercise considerable judgment in the choice of working stresses, along which line there are still many unexplored fields for research.

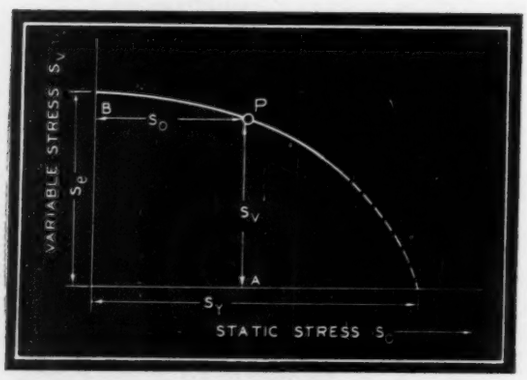

Fig. 2—Typical experimental line is shown of fatigue failure for combined static and variable stress

RATIONAL METHOD FOR DETERMINING WORKING STRESS IN SPRINGS—In general, the stress set up in a spring of any shape under given loads may be calculated by methods which will be discussed in subsequent articles of this series. If stress is plotted against time, a case frequently arising in practice is shown in *Fig.* 1, which corresponds to the usual condition in a valve spring. (It is assumed that the spring design is such that no surging or vibration due to resonance with harmonics in the cam motion occurs.) In this case a variable stress s_v is superimposed on a constant stress s_o. For most materials, experimental results will yield a limiting curve of failure similar to that shown in *Fig.* 2. In this figure the ordinates represent values of variable stress s_v which will just cause failure when superimposed on the static or mean stress s_o as given by the abscissas of the points on the curve.

Where there is no static stress the variable stress at failure becomes the ordinary endurance limit in reversed stress s_e so that the curve must intersect the vertical axis at a distance s_e from O. The stress condition represented by any point P on the curve consists of a static stress component $BP = s_o$ on which is su-

1. "Abstract of Progress Report No. 3 on Heavy Helical Springs", by C. T. Edgerton, *Transactions*, A.S.M.E., Oct. 1937, p. 609.
2. "Fatigue Characteristics of Helical Springs", by J. B. Johnson, *Iron Age*, March 15 and 22, 1934.
3. "Permissible Stress Range for Small Helical Springs", by F. P. Zimmerli, *Research Bulletin* No. 26, University of Michigan, 1934.
4. Hankins and Becker. "Surface Conditions and Fatigue Resistance of Spring Steels", *Journal* of Iron and Steel Institute, 1931, No. 2, p. 387.
5. Batson and Bradley, "Fatigue Strength of Carbon and Alloy Steel Plates as Used for Laminated Springs", *Proceedings*, Institute of Mechanical Engineers, 1931, p. 301.

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al Springs – Part I

min ing Working Stresses

UNDER the same title a series of articles by Mr. Wahl was published in MACHINE DESIGN several years ago which attracted widespread attention and created a continued demand for reprints. The accompanying article is the first of a four-part revised series to appear in this and the following issues. Each article has been entirely rewritten and supplemented with additional material based on research carried out during intervening years, the important points developed in the original articles, however, being retained. The author is connected with the research laboratory of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

perimposed a variable stress component $AP = s_v$. Although in some cases the line of failure has tended to approach the ultimate strength as the variable stress is decreased, the curve has been arbitrarily drawn so as to intersect the horizontal axis at the point s_y representing the yield stress. This is done since in general no working stress should exceed the yield strength of material[6].

Another common method of plotting fatigue test results for combined static and variable stress is shown in *Fig.* 3. Here two curves *a* and *b* are plotted, equidistant from the dot and dash line *c* representing the mean or static stress component. The *a* and *b* curves represent upper and lower limits of actual stress just required to cause fatigue failure. It is clear that at any point *P* the ordinate of the mean stress line *c* gives the static stress component s_o and the distance

6. Where the yield stress is not sharply defined (as is the case for most spring steels) it may be taken as the point where the plastic strain is 0.2 per cent. See "Concerning the Yield Point in Tension", by J. M. Lessells, *Proceedings*, A.S.T.M., 1928, p. 387. The yield point in torsion, in the absence of actual test data, may be estimated as 57 per cent of that in tension for ductile materials.

7. "Factor of Safety and Working Stress", by C. R. Soderberg, *Transactions* A.S.M.E., 1930, A.P.M. 52-2.

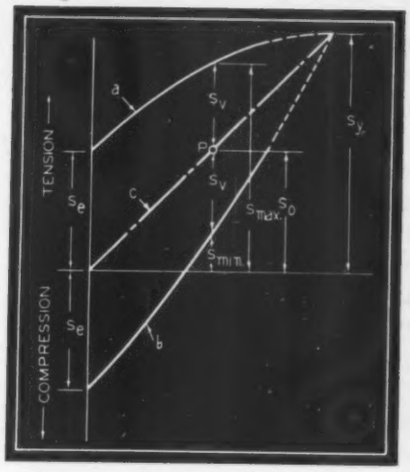


Fig. 3—This is another method of representing fatigue test results for combined and variable stress

between the mean stress line and either the upper or lower curve gives the variable stress component s_v. The maximum and minimum values of stress s_{max} and s_{min} corresponding to any combination of static and variable stress s_o and s_v may be read directly from the curves *a* and *b* as indicated.

In order to simplify the determinations of working stress in practical design, Soderberg[7] suggests that the curve of failure be replaced in a straight line connecting the points s_y and s_e as shown in *Fig.* 4 and the line *CD*. This line in general will be on the safe side when compared with the true experimental curve. Any combination of static and variable stress represented by point *P* on the line *AB* connecting the points at disances s_e/n and s_y/n from the origin would be defined as having a factor of safety of *n*.

From the geometry of *Fig.* 4, it may be shown that the factor of safety:

$$n = \frac{1}{\frac{s_{wo}}{s_y} + \frac{s_{wv}}{s_e}} \qquad (1)$$

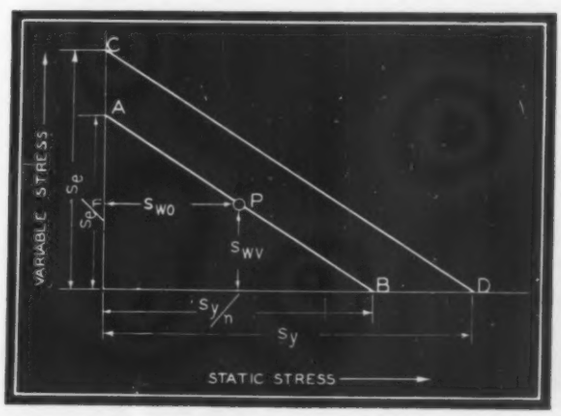


Fig. 4—Simplification of experimental curve of fatigue failure with method of defining factor of safety

where s_{wo} and s_{wv} are the static and variable components of the working stress respectively. It should be noted that these stresses may be either bending or torsion stresses. If torsion stresses are being considered, then s_y and s_e are the yield stress and endurance limit in torsion.

Instead of a linear law, an elliptical relationship may be assumed between the values of static and variable stress necessary to cause failure. In such cases the curve of failure[8] will be represented by the quadrant of the ellipse, *ACB* in *Fig.* 5 and intersecting the co-ordinate axes at s_y and s_e. If it be assumed that no stress should exceed the yield strength, the dotted portion of this ellipse should be replaced by the line *C B* extending at an angle of 45 degrees to the axis of abscissas, since when the variable and static components of stress represented by points on *C B* are added, the maximum stress will just equal the yield stress. It is believed that the elliptical curve as thus modified will in most cases give a closer approximation to the true curve for spring steels, but for certain materials it may give results on the unsafe side. On the basis of an elliptical relationship the factor of safety n becomes:

$$n = \frac{1}{\sqrt{\left(\frac{s_{wo}}{s_y}\right)^2 + \left(\frac{s_{wv}}{s_e}\right)^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where the symbols have the same meaning as those used in equation (1).

The results of some fatigue tests are plotted in *Fig.* 5 to enable a comparison to be made between the elliptical and the straight line relationships in the case of torsional fatigue stressing. The triangles represent the results obtained by Weibel[9] on tempered Swedish steel wire tested both in pulsating (zero to maximum) and reversed torsion, the surface on the wires being left intact. While these results show rather high values, they are among the few available for such a comparison. The circles in *Fig.* 5 represent test results by Hankins[10] on specimens of silico-manganese spring steel with machined surfaces. It may be seen that in these cases the elliptical law agrees quite closely with the test results. However, it should be noted that the straight line law, *Fig.* 4, is the safest to use in practice, particularly where complete test data are lacking.

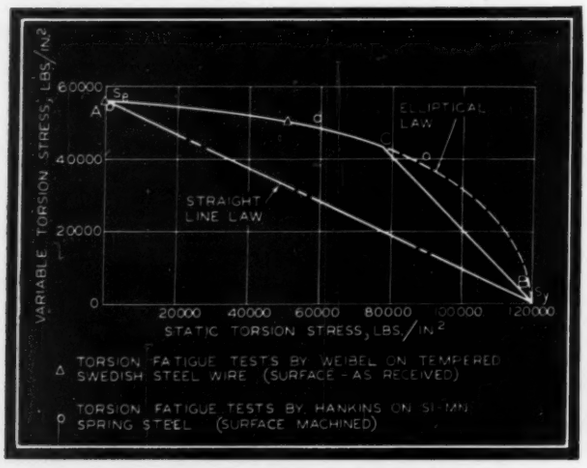


Fig. 5—Elliptical curve represents fatigue failure and comparison with torsion endurance test results

In calculating the static or mean stress s_o, the consensus of opinion at present[8] is that stress concentration effects may be neglected. Since stress peaks due to curvature in helical compression and torsion springs are rather localized, it is believed that they may be considered as due to stress concentration effects and hence may be neglected in computing s_o. It should be noted that the effect of direct shear in helical compression springs should be considered, since this is not a localized stress. In figuring the variable component s_v, however, stress concentration may not be neglected.

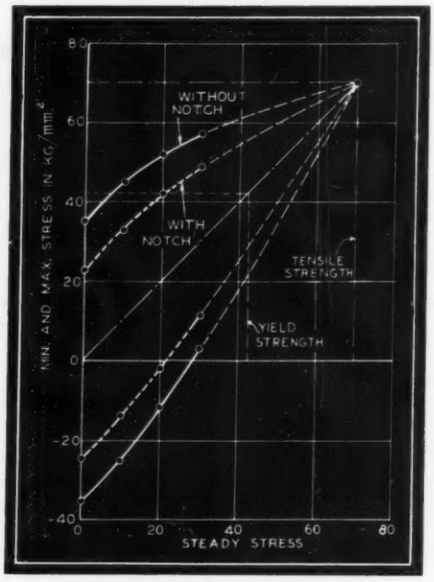


Fig. 6—Notch effect in fatigue stressing with initial tension, 0.7 per cent carbon steel

The justification for this method lies in certain fatigue tests on notched bars under combined static and variable stress. The results of one such test[12] on 0.7 per cent carbon steel bars are shown in *Fig.* 6, the full lines being results for specimens without stress concentration and the dashed lines for notched specimens. It may be seen that the mean or static stress represented by the dot and dash line is not diminished by the stress concentration effect, but the variable stress represented by the vertical distance between either the full lines or the dashed lines is

8. "Working Stresses", by C. R. Soderberg, *Transactions*, A.S.M.E., 1933, A.P.M. 55-16.

9. "The Correlation of Spring Wire Bending and Torsion Tests", by E. E. Weibel. *Transactions*, A.S.M.E., Nov. 1935, p. 501.

10. "Torsional Fatigue Tests on Spring Steels", by G. A. Hankins, Sept. of Sci. & Ind. Research, Special Report No. 9.

12. Stahl and Eisen, Vol. 52, p. 660. See also discussion by R. E. Peterson of Report of Research Committee on "Fatigue of Metals", published in *Proceedings*, A.S.T.M., 1937.

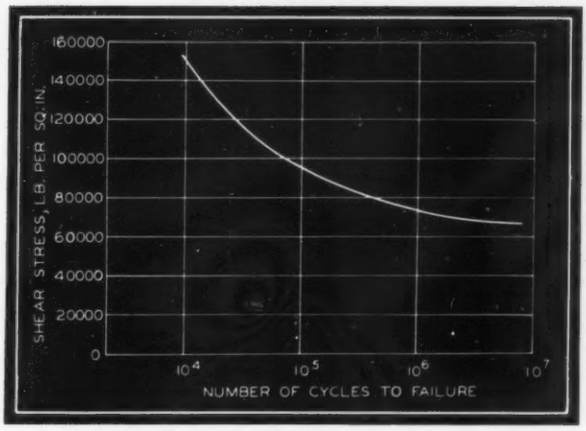


Fig. 7—Typical stress-cycle curve obtained from tests of helical springs

diminished in a more or less constant ratio by the stress concentration effect of the notch. The design method proposed by Soderberg for ductile materials (defined as those with more than 5 per cent elongation in the standard tensile test, which includes most spring materials) also neglects stress concentration effects in computing the static component of stress. While it must be admitted that available fatigue test data made for the purpose of evaluating stress concentration effects under combined static and variable stress are meager, it is believed that, for ductile materials at least, stress increases due to curvature in practical springs may be treated in this manner. This means that if the load is mostly static, an increase in working stress (calculated by using stress multiplication factor K) will be permissible[13] for springs of small index (ratio of mean coil diameter to wire diameter) as compared with that used for springs of large index. Where the variable stress is large, i. e. a stress range from zero to maximum, then nearly the full effect of the factor K should still be felt, except insofar as other effects such as plastic deformation during prestressing or "surging" modify this. This subject will be more fully discussed in Part II of this series.

OTHER CONSIDERATIONS IN DETERMINING WORKING STRESS—Where springs are subjected to relatively few cycles of loading, the permissible working stress may be considerably increased. Examples of such springs are those used in certain control mechanisms. A typical stress-cycle graph for helical compression springs of carbon steel stressed from zero to a maximum is shown in *Fig.* 7. It appears that for this type of stress application the permissible stress is about twice as great if subjected to only ten thousand cycles as if subjected to ten million cycles, assuming that some permanent set would not be objectionable. This behavior has been observed in alloy steels and in beryllium bronze springs[2]. However, it must not be inferred that such a large increase in the working stress is usually possible when the loadings are relatively few since in most cases the increased permanent set would seriously interfere with the operation of mechanisms of which the springs[1] form an integral part.

The general case of spring loading where the load cycles are of variable amplitude is represented in *Fig.* 8, which corresponds to a spring subjected to a constant static load on which is superimposed loads of varying intensity and frequency. Similar operating stress conditions occur in the ordinary railway car spring which is subjected to sensibly constant load, due to the weight of the car, on which is superimposed loads of varying intensity and frequency when passing over track irregularities, rail joints, etc. Experimental fatigue data giving results for cases where the amplitude of the variable component of stress changes with time are almost wholly lacking[14]. This subject presents a fertile field for future investigation and research.

The effect of surface conditions on the fatigue strength of springs has been the subject of a great deal of experimental work at the National Physical Laboratory in England. The results of this work on actual plates as used in leaf springs show conclusively that because of a decarburized layer on the surface combined with the stress concentration effect of surface irregularities produced by manufacturing operations,

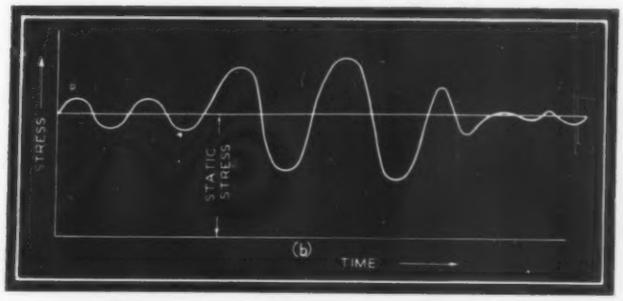


Fig. 8—Curve shows stress cycles of variable amplitude

the actual endurance limit may be but one-quarter to one-half that to be expected on the basis of tests on machined or ground specimens. For example, fatigue tests on 2 x ⅜ inch bars of heat treated 0.61 per cent carbon commercial spring steel (as used in leaf springs) made by Batson and Bradley[5] showed an endurance range, with the surface machined and ground, of 0 to 128,000 pounds per square inch. When the surface was left untouched the endurance range dropped to 0 to 42,000 pounds per square inch, a reduction of about two-thirds. The stress-cycle curves of *Fig.* 9 are plotted from data published by these experimenters and show the tremendous effect due to surface condi-

13. See the author's paper "Stresses in Heavy Closely Coiled Helical Springs", *Transactions*, A.S.M.E. APM 51-17 for a discussion of the factor K. It should be noted that this factor takes into account stress increases due both to curvature and direct shear.

14. "Fatigue Failure from Stress Cycles of Varying Amplitude", by B. F. Langer, *Journal of Applied Mechanics, Transactions*, A.S.M.E., Dec., 1937.
Also "Damage and Overstress in the Fatigue of Ferrous Metals", by Russell and Welcker, *Proceedings*, A.S.T.M., 1936. Part 2, p. 118.

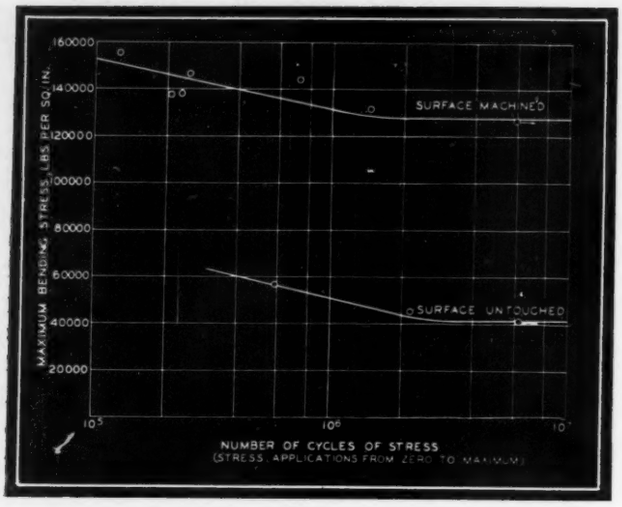


Fig. 9—Stress-cycle curves for 0.61 per cent carbon commercial spring steel plate

tions in this particular case.

Similar results were obtained by Hankins and Ford[15] who found for one silico-manganese steel an endurance limit of ± 60,000 pounds per square inch in reversed bending on specimens which had been heat-treated after grinding to size. In this case there was a decarburized surface layer left there by the heat-treating process. When the tests were made on specimens of the same steel and given the same heat treatment but having a thin layer of surface material ground off *after* heat treatment, the endurance limit increased to ± 103,000 pounds per square inch. Further tests were made on specimens which had been heat treated in a neutral atmosphere in such a way as to prevent the formation of a decarburized layer; in this case the endurance limit was ± 107,000 pounds per square inch or practically the same as for the specimens ground after heat treatment. This indicates that the decarburized layer was to a large extent responsible for the lower endurance limits found on specimens which had not been machined after heat treatment. These tests are extremely interesting in that they afford an indication of what may be done by means of special heat treatments for the purpose of increasing the fatigue strength of actual springs.

This reduction in endurance strength because of surface effects has also been observed in reversed torsion fatigue tests by Lea and Heywood[16] on chrome vanadium spring steel wires. These investigators found that where the wires had been machined and polished the torsional endurance limits were increased to almost twice the value obtained from specimens in the unmachined condition. Swan, Sutton, and Douglas[17] also report for chrome vanadium steel under pulsating torsional stress (from ¼ the maximum to the maximum) an increase of around 50 per cent in endurance range where the specimens were machined and polished. The results of these various tests show the importance of the surface conditions of spring steels when under torsion fatigue stressing. On the other hand, it should be mentioned that torsion fatigue tests on Swedish valve spring wires by Weibel[9] showed practically no difference in the torsional endurance limit between specimens with the surface untouched and those having the surface layer ground off.

On cases where springs are subjected to even mildly corrosive action while under fatigue stressing, the endurance limit for most ordinary materials is greatly reduced. In such cases fatigue tests must be carried out for many more than the usual ten million cycles[18]. A large number of corrosion fatigue tests on spring materials, carried out by McAdam[19] show the tremendous reduction in the endurance limit in spring materials subjected to either fresh or salt water corrosion fatigue. For spring steels subject to fresh water corrosion fatigue, the value of endurance limit obtained was but one-fourth to one-ninth that obtained by tests on specimens in air. Higher values of endurance limit under corrosion conditions were obtained on corrosion resistant steels, while cadmium-plated springs showed much higher endurance limits under such conditions, i.e., about twice the value was obtained for a spring steel with a plating than without. These examples show that the designer must either protect the springs from corrosive action, or else use extremely low working stresses. Even then, there is no assurance that eventual fatigue failure will not occur, if sufficient repitions of stress take place.

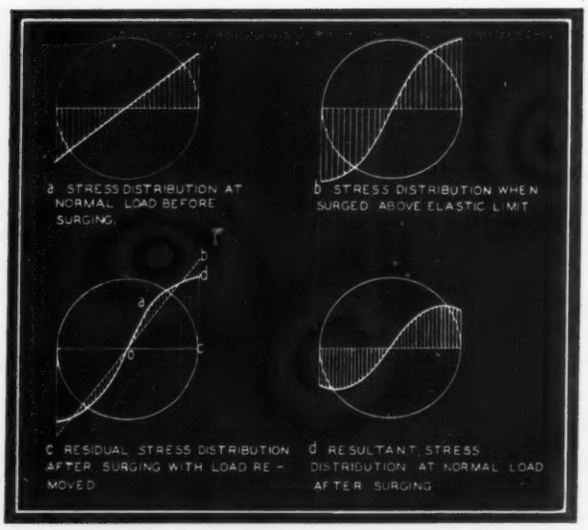

a STRESS DISTRIBUTION AT NORMAL LOAD BEFORE SURGING
b STRESS DISTRIBUTION WHEN SURGED ABOVE ELASTIC LIMIT
c RESIDUAL STRESS DISTRIBUTION AFTER SURGING WITH LOAD REMOVED
d RESULTANT STRESS DISTRIBUTION AT NORMAL LOAD AFTER SURGING

Fig. 10—Distribution of stresses over the cross section of helical spring of large index

15. "Mechanical and Metallurgical Properties of Spring Steels as Revealed by Laboratory Tests," by Hankins and Ford, *Journal* of Iron and Steel Institute, 1929, No. 1, page 217.

16. "The Failure of Some Steel Wires under Repeated Torsional Stresses," by Lea and Heywood, *Proceedings,* Institute of Mechanical Engineers, 1927, page 403.

17. "Investigation of Steels for Aircraft Engine Valve Springs," *Proceedings,* Institute of Mechanical Engineers, 1931, vol. 120, page 261.

18. "Corrosion-Fatigue of Metals", by J. H. Gough, *Engineer,* Vol. 154, 1932, page 284.

19. "Fatigue and Corrosion Fatigue of Spring Materials," by D. J. McAdam Jr., *Transactions,* A.S.M.E., APM 51-5.

Another factor which must often be considered in spring design is the effect of permanent set in springs under more or less continuous loading. In many cases, to insure proper functioning of mechanisms of which they form component parts, springs must exert a constant force at a given deflection for long periods of time. When springs are loaded to stresses approaching the yield point of the material, there is danger that considerable permanent set or creep may occur even at normal temperatures; for such applications, therefore, the working stress must be reduced. The effect of permanent set becomes more pronounced at elevated temperatures and for such cases, a rational method of design would be to use the results of long time relaxation tests at high temperature, i.e., tests in which the springs were stretched to a given length at the given temperature and the decrease in load determined as a function of time.

Another factor which is hard to evaluate is the effect of residual or trapped stresses set up during the manufacture of the spring. Helical compression springs are often surged or compressed solid so that they take a permanent set. What happens in the spring when this is done may be seen by reference to *Fig.* 10. The first sketch (*Fig.* 10a) shows the shear stress distribution along a diameter of the cross section of a helical spring of large index at a load such that the stresses are below the torsional elastic limit. When the spring is surged or compressed so that permanent set occurs the stresses exceed the elastic limit and the distribution of stress becomes somewhat as shown in *Fig.* 10b. This curve will be similar to a torsion test curve of the spring material. On releasing the surging load, residual stresses will be induced somewhat as shown in *Fig.* 10c.

Stresses Can Be Determined

The residual stresses thus set up may be calculated approximately from the condition that the moment of the stress represented by the triangle *obc* must be equal to the moment of the stresses represented by the area *oadc*. When normal load is again applied to the spring, the resultant stress distribution is somewhat as shown in *Fig.* 10d. It is clear that by surging the spring we have induced residual stresses of opposite sign which reduce the resultant maximum stress when normal load is applied. An opposite effect would have occurred if the surging load had been in a direction opposite to that of the normal load on the spring. In this case the maximum stress in the spring would have been increased.

A quantitative evaluation of the net effect of these residual stresses may best be made by actual fatigue tests in conjunction with diagrams similar to that of *Fig.* 3. Such investigations would provide the designer with much useful information as to the best amount of prestressing or surging required for optimum resistance to repeated stress.

There is always an unavoidable variation in the size of wire or plate used in making springs. The effect of these variations may often be large, especially when it comes to obtaining proper load-deflection characteristics. For example, in the case of helical springs, a cumulative variation in both coil and wire diameter of only 1 per cent will result in a 7 per cent change in the load deflection characteristic of the spring. Hence, it may be necessary to allow the spring manufacturer some leeway in choosing the other spring dimensions to compensate for these unavoidable variations in sizes of commercial wire stock. For example, if the wire for making helical springs happens to be slightly undersize, the spring manufacturer may be able to compensate for this by slightly reducing the coil diameter. In most cases this slight reduction in coil diameter would not be detrimental to the operation of the spring. In commercial springs, actual stresses and load deflection characteristics may easily vary 10 per cent above or below the calculated values, and hence this must be considered in design.

Factor of Safety Varies

In choosing the factor of safety, n (as defined in equation 1) the designer must be guided by a great many considerations. If the consequences of failure are very serious, then a higher factor of safety must be used, while if a broken spring causes but little inconvenience, it may be more economical for the designer to lower the factor of safety. Where springs are made of uniform and high grade material, and where close control of the manufacturing process is maintained, lower factors of safety may safely be used. If, in addition, accurate test data on the particular spring materials used are available, in cases where the test conditions approximate the service conditions, the design factor of safety may again be reduced. On the other hand, ignorance of the peak loads acting, or the effect of unknown factors such as corrosion or temperature effects may dictate an increase in this factor. In many applications, the amount of permanent set is the limiting factor and must be considered.

While the purpose of this series of articles is to acquaint the designer with some of the fundamentals underlying spring design to enable him to make an intelligent selection of springs for his purpose, it is nevertheless advisable, in cases where important spring applications are concerned, to have the design confirmed by consultation with the spring manufacturer in order to benefit from the latter's experience.

In the next article (Part II) the design of helical compression and tension springs will be discussed, with particular reference to the effect of spring index on the choice of working stresses.

Designing Plastic Parts from Standpo

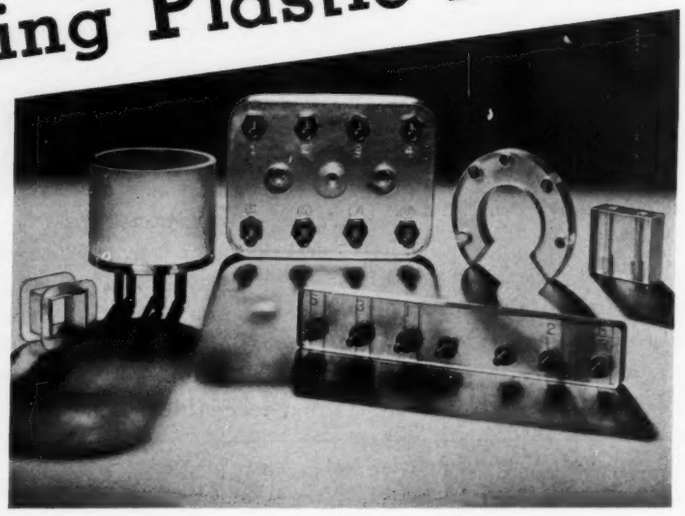


Fig. 1—Such parts as coil forms, tube bases and terminal blocks produced from polystyrene, a material of high dielectric strength

By J. Delmonte

SPECIAL consideration must be given the design of plastic parts for mass production. Tolerances, fabrication, and costs must conform to the principles established by the remainder of the design, to insure economical production. This entails, among other things, a study of the proposed machine in the light of the possible elimination of extra screw machine parts, brackets or bushings by plastic parts. The elimination of extra parts speeds up production, by simplifying assembly and handling. The specification of adequate working tolerances for the plastic parts will do likewise. It will often be found advantageous to adhere to the standard sizes and specifications for organic plastics, as established by such organizations as the National Electrical Manufacturers association, (NEMA), primarily because the manufacturers quote better prices and promise quicker delivery dates, for standardized materials.

About 25 years ago, a Dr. Baekeland received patents for his phenol-formaldehyde condensation products. The infusible molded product he called "Bakelite," and the laminated structure he termed "Bakelite Micarta." Since then designing engineers, and subsequently shop personnel, have acquired the habit of referring to all molded plastic materials as Bakelite and laminated plastic materials as Micarta or linen Bakelite. This terminology, although incorrect for the many other plastic products, still prevails in the engineering department and shop. The designing engineer does not specify steel parts without their SAE rating or similar designation. By the same token, it is reasonable to expect the same treatment of plastic parts. As a result of the casual treatment of plastic terms, custom molders are prone to ignore any specifications of nonmetallic materials at the bottom of the drawing and provide, regardless of specifications, the particular grade of phenol-formaldehyde molding powder which, in their own judgment, is best. Such practice either connotes lack of information on the part of design men, or else lack of thoroughness in studying the merits of the intended application.

An examination of engineering department procedures for illustrating cross sections of synthetic materials reveals a wide variance in detail, though the heavy oblique lined cross section is preferred. Not only should a more universal illustrative procedure for plastics be adopted, but also a more coherent terminology. The average designer and shop personnel would be confused by reference to plastic products by their correct chemical terminology such as phenol-formaldehyde or methyl-methacrylate. For this reason Table I is suggested as a proper guide for the specification

ndpoint of Production

molded part appear to be necessary, consultation with the custom molder will be helpful in assigning the proper and final specification for the material.

Little difficulty should be encountered in specifying laminated phenolic plastics. The National Electrical Manufacturers' Association has indicated the minimum acceptable standards for the majority of these plastics. As may be observed by examining Table II, the electrical and mechanical characteristics are alternately emphasized for each type. It should encourage the designer to note that the great majority of manufacturers of laminated phenolic plastics have adopted the trade designations of NEMA, not only in their descriptive literature, but also on all stock items and price lists.

Plastic parts used for mass production usually entail a number of laminated phenol plastics that are punched out of sheet stock or cut from tubing or rods. Washers, spacers, bushings, terminal strips, guards, insulation, supports (see *Fig.* 4) of every description constitute typical laminated plastic parts. Usual practice is for the manufacturers of these materials to furnish the final fabricated item. Liberal tolerances should be allowed with due cognizance of the fact that holes punched in laminated phenol plastic stock tend to be smaller than the punch size, and that out-

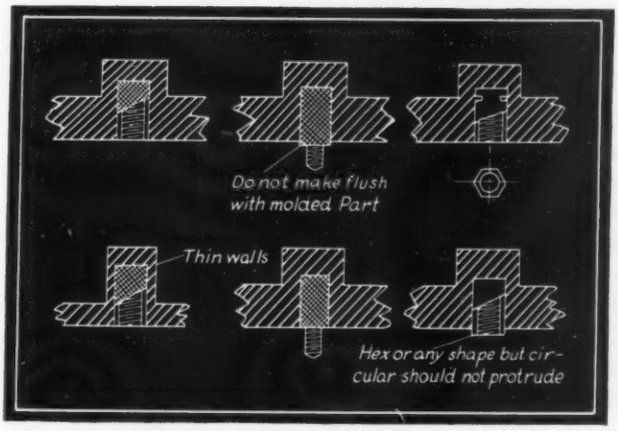


Fig. 2—Proper design for inserts in plastics is shown in the upper row. Incorrect practice is illustrated below

Fig. 3—By making flash line at B-B, single cavity mold may be used and excess buffing avoided which would be necessary if fin were at A-A

of common plastic products. Two columns are listed, the first giving the correct chemical terminology and the second setting forth the suggested nomenclature. Because of many different tradenames for some of these materials reference to them is purposely avoided in this article.

After establishing a workable and accurate nomenclature for plastic products the designing engineer is better equipped to discuss materials. It should be remembered, however, that Table I is only a general classification; each type of material has many ramifications. For example, the molded phenol plastics are available in numerous composition, each emphasizing some specific property in the final part. For instance, *Fig.* 1 shows a plastic of Bakelite polystyrene, developed especially for high dielectric strength. Some assure a high lustre; others emphasize heat resistance, and still others are intended for insulating or low water absorption. When specialized qualities in the

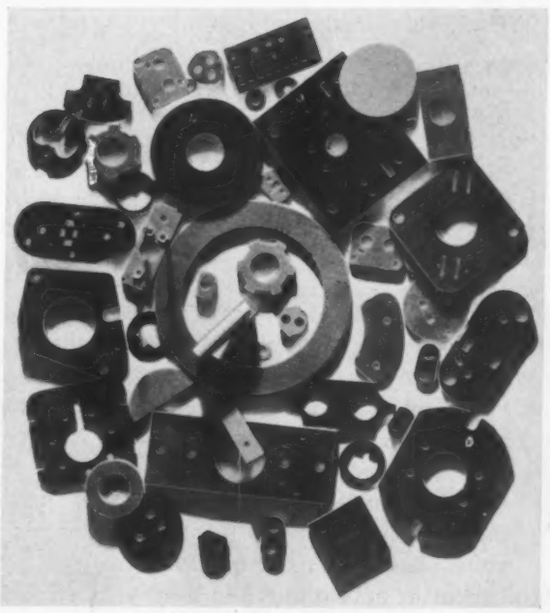


Fig. 4—Plastic parts for mass production include laminated types that are punched from sheet stock or tubing

side dimensions tend to measure greater than the die. Punchings of this type should cause little difficulty on the assembly line. If subject to abnormal conditions during operation, a special analysis and design of the part may be necessary.

Laminated phenolic plastic parts may be fastened to other metal parts by machine screws or rivets. Adequate thickness of the plastic should be allowed in the design because too great a bending stress from a screw or rivet may crack the piece, often passing unnoticed until the unit is in service. The same thought applies to laminated phenol tubing which may serve as a structural member.

TABLE I

Suggested Nomenclature for Plastics

Chemical Names	Simplified Terms
Phenol - Formaldehyde (molded wood flour filler)	Molded Phenol plastic (wood flour filler)
Phenol - Formaldehyde (molded shredded fabric filler)	Molded Phenol Plastic (shredded fabric filler)
Phenol - Formaldehyde (molded asbestos filler)	Molded Phenol Plastic (molded asbestos filler)
Phenol - Formaldehyde (laminated-canvas, linen, paper base)	Laminated Phenol Plastic (canvas, linen or paper base)
Phenol - Formaldehyde (cast)	Cast Phenol Plastic
Cellulose Nitrate	Cellulose Nitrate (sheet, rod, tubes or bars)
Cellulose Acetate	Cellulose Acetate (sheet, rod, tubes or bars)
Cellulose Acetate (molded)	Molded Cellulose Acetate
Methyl Methacrylate	Acrylic Plastic (molded or sheet)
Urea Formaldehyde (molded)	Molded Urea Plastic
Glyceryl Phthlate	Glycerol (trade-name)
Vinyl Resins	Vinyl Plastic (molded or sheet)
Polystyrene Resins	Styrene Plastic (molded or sheet)
Casein	Casein Plastic
Phenol-Furfural	Phenol-Furfural Plastic

Molded plastic parts require careful study in designing for production. In the design of machines the molded parts fall into one of two classifications:

(a) Parts intended for exterior housings which must be styled for appearance

(b) Parts intended for mechanical or electrical service which fulfill specific requirements, such as the simplification of assemblies, elimination of noise, shock absorbing qualities, etc.

Attainment of appearance and beauty in a molded plastic is not realized overnight. An industrial artist in consultation with the design engineer may prepare sketches of several possibilities. From these he can either carve a wooden form or shape a model from molding clay. At this point, all interested parties including the sales manager should confer on the preliminary designs, and having selected one the engineer will make a layout of the proposed design. A part should then be machined from cellulose acetate or laminated phenolic plastic stock following *exactly* the dimensions indicated upon the drawing. This takes time but is wise procedure.

Design Corrections Made on Model

It is good practice to give the drawing to the custom molder or shop molder for his criticism and suggestions for eliminating costly operations. The finished model should be studied carefully once again as it may have a different aspect from the preliminary crude clay or wooden model. Objectionable highlights, sharp curvatures, or apparently flat, unbecoming areas may be observed, and changes made. Corrections at a later stage of production would prove costly. A single cavity mold may now be produced by the molder from the final, approved drawing of the part. A few molded samples will give information on the shrinkage, accuracy of the dimensions that may be expected, and general suitability of the article. These samples must be inspected meticulously and applied to forestall further difficulties in production. Following this, the machining or hobbing of the multiple cavity molds will put into action the steps leading to the production of the molded part.

INSPECTION—The inspection of the first samples submitted by the molder must be made the subject of a thorough study. Metal parts that are to be assembled thereto should be attached in the correct manner and all clearances and tolerances carefully studied. Templates, contour gages, and cavity blocks should be used to check the nonuniform curvatures and recesses in the molded parts against dimensions on the final drawings.

An excellent inspection guide for the machine builder, particularly if the housing is entirely a molded plastic, is a transparent housing of one of the moldable transparent resins of cellulose acetate or acrylate. These molding powders can be utilized without difficulty in the conventional mold. A model of this nature will permit an examination of the assembly features of a particular machine and perhaps some unforeseen difficulty.

INSERTS—The application of inserts has always been an important advantage of molded plastics. Though the cost of the part is higher, there are economies gained by minimizing the handling of extra pieces in production and the elimination of drilling and tapping.

There are three ways in which the inserts may be

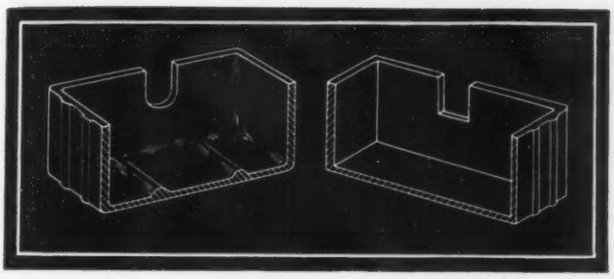


Fig. 5—Additional strength is built into plastic molding by designing ribs as shown in view at left

introduced into the molded piece:

(a) Placing in mold preform (in the preform the molding material is roughly pressed to the shape of the final mold cavity)

(b) Positioning insert in mold cavity (this method is particularly adapted to injection molding)

(c) Putting insert in place after the molded piece has been removed and is still hot.

Methods (a) and (b) are used most frequently. From the design viewpoint, there are two good methods for securing the inserts within the mold to prevent them from turning or pulling out:

1. Hexagon or square stock—undercut (molding material will fill the undercut completely, and prevent it from pulling out)
2. Round stock—deep diamond knurl (at least .010 inch deep is good practice).

The advantages of these designs may be understood better by referring to the accompanying illustration, *Fig.* 2. By way of explanation, it should be pointed out that if a hexagonal-shaped insert protrudes from the molded piece, the mold cost will be higher. The reference to the male threaded insert calls attention to a common mistake. If the insert is flush there is a possibility of the molding material running down the threads. The preferred position for molding inserts is in a vertical direction, though short horizontal inserts are sometimes employed. Large metal cores or inserts are sometimes used with cellulose acetate, especially with handles or knobs liable to breakage. The excellent molding and flowing qualities of this thermoplastic resin permit the adaptation of a plastic

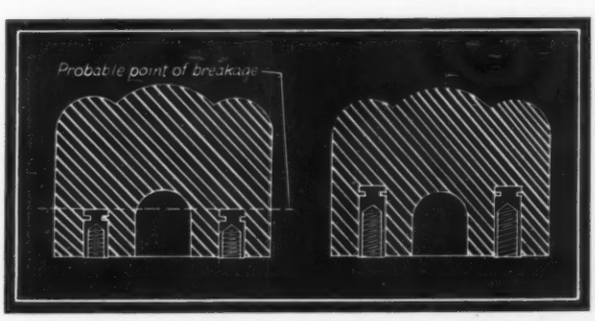


Fig. 6—If insert hole ends in line with other cavity as shown at left, breakage is liable to occur. Improved design is shown at right

shell to a relatively large metal core.

The design possibilities of molded plastics are enhanced through the use of inserts. They are not limited to metal inserts—materials such as wood, fiber or rubber are sometimes applied. In fact, a rubber coating is often applied to a large brass or copper insert that is to be molded into an article. This will prevent cracking when the plastic shrinks about the insert. On metal inserts, cadmium, nickel or chromium plating is not affected by the molding operation. Usual practice is for the company purchasing the molded parts to furnish the metal inserts which

TABLE II

Standard Laminated Plastics

Grade (NEMA designation)	Specific Qualities	Base
X	General purpose, good insulation	Paper
XP	Punching, good insulation	Paper
XX	Good finish, general purpose	Paper
XXX	Superior insulating properties	Paper
A	Superior heat resistance	Asbestos
D	Good machining and insulation	Paper
C	High impact strength, resilient	Canvas
CE	Same as "C", better electric qualities	Canvas
L	Good machining and punching	Linen
LE	Same as "L", better electric qualities	Linen
CG or LG	Similar to "C" and "L" with added graphite for self-lubrication	Canvas or Linen

are generally screw machine parts. A saving is effected by this procedure as the manufacturing organization is generally tooled better than the custom molder to turn out screw machine parts.

There is no secret in producing good designs for molded parts. General rules are not difficult and if observed will not only improve the excellence of the design, but materially reduce the costs. Though the improper design of molded plastics may cause many difficulties, typical precautions and specific references to good practice are cited.

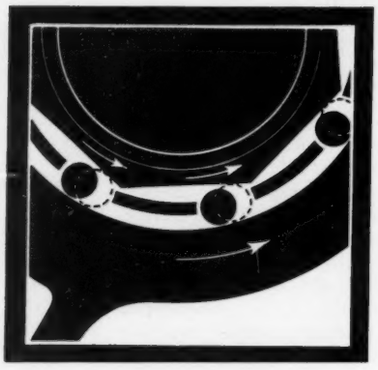
LOCATION OF FLASH LINE—Dotted lines in *Fig.* 3 show the correction of an improperly designed molded handle. The flash or fin, if present at A-A, would require a heavy buffing for removal. In addition, multiple cavity mold costs would be higher as hobbing methods could not be employed. On the other hand, the appearance of the flash line at B-B, which now becomes the widest dimension in the improved dotted design, may be easily finished. Dotted lines on the side view also indicate a new group of parallel ridges for improving appearance.

THIN WALLS—As molded pieces are comparatively

(*Continued on Page* 50)

Fig. 1—Right—Roller clutch unit broken open to reveal relations between core, rollers, driving ring and hold-back ring

Fig. 2—Below—Diagram of section of clutch, indicating manner in which rollers lock between eight-sided core and outer rings



Design's "Big Three"—Safety, Reliability and Economy

By George A. Gowdy

Chief Engineer, Stoker Division, Morse Chain Co.

Fig. 3—Transmission assembly showing location of clutch and other elements

UNTIL within recent years it has been necessary for the average householder to produce whatever heat his home might require "by his own hand." However, in view of the remarkable developments in various electrically operated domestic appliances, it is only natural that automatic heating also should become a requirement of the average home.

In this field the domestic coal stoker has come to hold an important position. Not only is its initial cost now within the average income bracket but furthermore its fuel and operating costs are in most cases actually less than with hand-firing.

Surveying this field, Morse engineers saw

the need for a stoker of modern design to be built in but one model, that one model to be flexible enough to cover the entire domestic range. Such a stoker would of necessity require a coal feeding mechanism with unlimited flexibility between "no feed" and its maximum capacity, which was set at 50 pounds per hour.

These engineers realized that not only would it be necessary to adjust the rate of burning to suit the general size of the installation—for example 20 to 30 pounds per hour—but also that a more than ordinarily exact degree of feed adjustment would be essential to conform to the requirements of each individual heating plant and heating condition in order to obtain maximum efficiency. From a manufacturing viewpoint, this unity would obviate a multiplicity of parts and operations and would permit the use of modern line production methods, which in turn would allow retail sale of the stoker at an attractive price.

The first problem encountered was that of transmission design. A very compact unit was required with a speed reduction from 1750 down to 1½ revolutions per minute maximum on the main drive shaft. It had to have an infinite speed adjustment on that shaft—that is, from 0 to 1½ revolutions per minute with infinite steps. Spur gears were, of course, out of the question because of their bulk and inflexibility. After considerable research and consideration of several designs the roller clutch mechanism shown in *Figs.* 1 and 2 was evolved. This fulfilled all of the requirements.

As can be seen in *Fig.* 3, a hardened and ground high speed shaft with an integral worm is used to drive a large worm wheel which floats on the main shaft and has a projecting eccentric cam on one side. A drop forged cam follower arm is pivoted in the upper corner of the transmission case and is linked to the driving ring of the roller clutch mentioned in the foregoing paragraph.

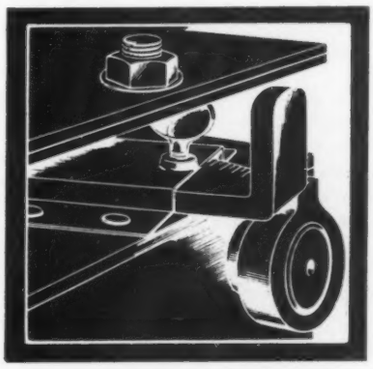


Fig. 4—Slide bar which gives infinite adjustment to rate of feed of stoker

The clutch mechanism itself consists of an eight sided core (see *Fig.* 2) which is common to both the driving and the hold back rings. The driving ring is oscillated by the cam follower, as is apparent in *Fig.* 3, and on the forward or up stroke it rotates the main shaft by the wedging action of the rollers on the core, as shown in *Figs.* 1 and 2. On the return stroke, the driving rollers release and the hold back ring, which is anchored to the transmission case, locks the core through its set of rollers, and prevents reverse rotation of the main shaft.

Infinite rate of feed adjustment is obtained by a simple sliding bar arrangement. This slide bar, which is depicted by *Fig.* 4, contacts a dog on the cam follower shaft (see upper right hand corner of *Fig.* 3) and limits the drop of the follower arm, thereby controlling the oscillating arc of the driving ring. Since the cam cycle is constant, any degree of rotation on the main shaft per revolution of the cam is obtained simply by controlling the extent to which the arm follows the cam. Feed shutoff is accomplished by setting the slide bar at its extreme forward position, thus holding the follower clear of the cam. A thumb screw locks the bar in any desired position.

Motor Has Resilient Mounting

A resiliently mounted ¼ horsepower motor of capacitor type is mounted on the transmission cover by means of a base having two formed lugs which hook into two slots in the cover. A conventional short center 1:1 drive is used, belt adjustment being provided by two cap screws which carry the motor weight. With this arrangement the motor readily can be demounted simply by removing the belt.

To prevent the escape of gas fumes and coal dust from the hopper, a rubber gasket of hollow section is imbedded in a formed channel in the hopper body. This gasket is compressed by a lip on the cover when the latter is closed. A snap lock similar to those used on automobile doors latches the cover tightly, thus insuring gas-tight sealing of the hopper. As a further precaution, a constant low air pressure is maintained in the hopper to keep gas or fumes from working back from the fire into the hopper, through the feed screw housing.

Coal is propelled from the storage hopper to the combustion retort through a cast tube, by means of a conventional screw conveyor. At the outlet of the hopper—a point where any large foreign material in the fuel might possibly jam the conveyor screw—a cleanout plate of generous size is provided. In addition to giving access to the conveyor tube, this plate is so designed as to present a shearing edge to the coal at the point where the fuel leaves the mass in the hopper to enter the tube. With this arrangement coal crushing is largely reduced, which results in easy and quiet operation.

Forced draft is provided by a fan of squirrel cage type. This is mounted on one end of the high speed shaft of the transmission and operates in a housing cast integral with the transmission case. Its control is dual; by a manually operated damper on the fan inlet, and by an automatic damper which adjusts the volume of air passing through the wind tube in relation to the fuel bed condition.

The retort, or actual combustion unit, is attached to the end of the coal conveying tube, and is connected

to the fan by a sheet metal wind tube. The assembly consists of the wind chamber, tuyere section and coal delivery end of the feed screw housing. The latter flares out gradually at the top to effect low frictional resistance to upward travel of the coal and to start a desirable spreading of the fuel bed.

The tuyeres are made up of small cast sections to allow for expansion and ease of installation. Carefully designed slots project the air into the fuel bed, at the same time preventing any infiltration of fine coal into the wind chamber. The upper portion of the tuyere block is pyramidal in shape so that as little surface as possible is in actual contact with the fire. All parts exposed to the fire are of nickel alloy which resists excessive growth and oxidizing effect of high heat.

One of the important features of the retort assembly is what is known as the combustion equalizer. This is a scientifically designed baffle located in the retort throat. There is a natural tendency for fine coal to work to the bottom of the feed tube, thus being forced to the far end of the retort, and for coarse coal to come to the surface and fill the near end. Unless these conditions are corrected the air flow is seriously restricted at one end by concentration of fine material, while air is released in excess volume at the other end through the coarse fuel. The result of this segregation

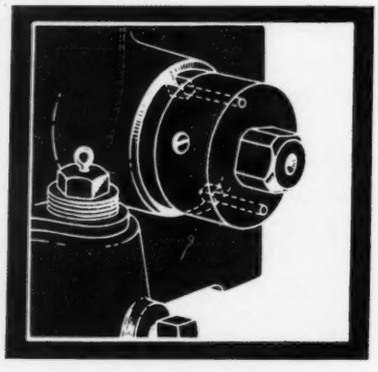


Fig. 5—Shear pins connecting feed screw to driving element protect transmission in event feed should lock

is an uneven and inefficient fire—hot in one portion and smoky and dull in the other. With the combustion equalizer however, the coal is thoroughly mixed as it leaves the end of the coal screw and so is delivered to the retort in the state of uniform density necessary for the most efficient combustion.

Two separate and distinct safety features are provided; one to protect the driving mechanism against sudden locking of the feed screw, the other for protection against gradual overloading. Shear pins—shown in *Fig.* 5—are used as connecting links between feed screw and driving medium of the transmission, and an automatic overload cutout is built into the motor. This cutout serves to protect the motor against gradual loads which might exceed its normal capacity and still not cause the pins to shear. A clear idea of the location of the shear pins in relation to the mechanism as a whole can be gained from *Fig.* 3. The disk by which they are carried extends out from the boss on the front center of the transmission case.

Operation of the stoker and control of the heat produced by the plant is effected by a group of electrical instruments usually consisting of a thermostat, a combination relay and timing device, and a limit control. The thermostat is centrally located in the space where the heat is to be controlled and operates the relay which starts and stops the stoker according to the heat requirements. The thermostat is usually of low voltage to facilitate installation and wiring.

Timing Device Maintains Fire

There may be extended periods when operation is not produced by the thermostat. Therefore a timing device with an adjustable operating cycle is used in the main control circuit. This permits the unit to run for short periods at predetermined intervals so spaced as to maintain the fire independent of the thermostat.

An abnormal condition—such as a draft from an open door or window—might cause the thermostat to operate the stoker continuously. Therefore a safety or limit control is cut into the motor line. By stopping the stoker at a set temperature this prevents the plant from overheating. Furthermore, it does not allow resumption of operation until the unit has cooled down to a safe point—regardless of the settings of the other instruments. Low water cutoff instruments are available for boilers, and automatic night setback controls —including synchronous clocks—can be furnished to those who seek the highest possible degree of economy, convenience and comfort.

In developing the design careful consideration was given to operating convenience. For instance, two simple thumb and finger adjustments control all functions. Also, the hopper opening is low and is correctly slanted for easy loading.

Modern materials and construction methods have been employed to advantage. The hopper panels are die formed from copper-bearing steel and are assembled by spot welding. Shrivel baked enamel is used to provide a finish resistant to rough usage. Hinges are die cast and finished in bright chromium. Chinese red pencil striping is used on the motor cover handles, hinges and name plate lettering for contrast.

In keeping with the modern trend, compactness and eye appeal were considered of prime importance in the hopper design and so a symmetrical "streamlined" body was finally evolved. This houses the entire mechanism and provides ample coal capacity. Large radii are used on all corners and unsightly projections and irregular surfaces have been avoided. Chrome finished hardware is used to add a decorative note without being unduly ornamental and the neutral gray suede finish has been adopted because it lends itself effectively to any basement color scheme.

How Would Upset Parts Fit Your Picture?

By Guy Hubbard

WHEN mechanical fastenings are mentioned, the idea of bolts will immediately come to mind. A train of thought thus started then may swing to a manufacturing process commonly called "cold heading," but which more properly should be called "cold upsetting." For a number of years engineers and designers generally have been familiar with the fact that a widening variety of thoroughly dependable bolts, screws and other common fastening elements are produced economically by the cold upsetting process. Not so well known to many of them however is the fact that recent developments in machinery, materials, dies and methods have pushed the possibilities of cold upsetting far beyond the realm of simple bolt making.

Fig. 1—Mostly automotive details, this group of the more intricate parts produced by cold heading and thread rolling suggests broad possibilities to designers in other fields

These developments actually have made this process one of the most important methods for the low cost quantity manufacture of interchangeable parts of small and medium size. Not only can the more common parts be produced accurately and at low cost in this manner, but also many unusual details which would be expensive and difficult—if not impossible—to machine on account of their peculiar shapes and the nature of their material, can be so produced in dies, without requiring secondary operations even for finishing.

Other parts, which ordinarily—as conventionally made—would require the assembly of several pieces by screwing together or welding, can be cold upset in one solid, cleanly designed piece of minimum bulk. An outstanding example of this is the integral part illustrated in the heading of this article.

The range of materials which can now be worked successfully and to

close limits by upsetting also will be a surprise to any designer who may have thought of the process merely as one for the heading of low carbon steel bolts. In addition to the always-useful low carbon alloy steels, all of the stainless steels and heat and corrosion resisting alloys, special steels, standard and special brasses and bronzes, aluminum alloys, as well as Monel metal, Invar, etc., can be thus worked.

As a matter of fact the process is especially suited to the making of parts from these more expensive materials because it handles them with little or no waste. Therefore the designer often will discover that the use of such materials—formerly ruled out because of prohibitive scrap losses—is now made possible through redesign of the parts for upsetting.

As in the case of many another modern development in parts making, the automobile industry deserves credit for having put on the pressure which has resulted in bringing out today's possibilities in upset products. Those upon whom much of this pressure was exerted were companies whose business was the making of parts for other manufacturers and who had a foundation of years of experience in the quantity production of cold headed bolts. Starting with this basic experience and making use of the "bolt heading" machines with which they already were equipped, these manufacturers broke away from their standard bolt traditions first by undertaking to make small special fastenings—usually of rather simple shape and of relatively small size such as those shown in *Fig.* 4 on Page 45.

Then some of them, sensing the full import of the new trend, put development engineers to work, enlarged their tool room and heat treating facilities, installed batteries of much heavier and more powerful upsetting machines and through the medium of trained sales engineers really began to go after this business of upset parts.

Engineers in the automobile industry are now so thoroughly familiar with the possibilities of upset parts that they have come to specify them more or less instinctively throughout their designs. Designers in a great many other fields of interchangeable manufacturing, however, have yet to realize that many of their parts also can be—with minor changes

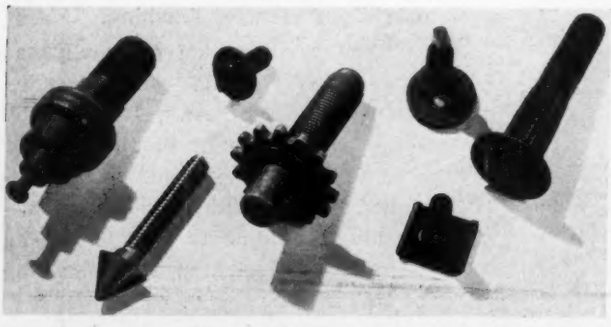


Fig. 2—Cold upsetting saves much material here and also eliminates costly subsequent operations

perhaps—manufactured by a specialist in upset work not only at a great saving in cost but also with improvement in quality and appearance.

There is no definite rule or simple set of rules by which a designer can determine by himself whether or not a part should be made by upsetting. Unless it happens to be a very simple part, numerous variables enter into the matter. After having studied some of the recent developments, the writer is convinced that any designer upon whom devolves the responsibility of specifying parts will do well to visit a plant where cold upsetting is being done in the modern manner. The idea is not so much to learn in detail how it is done, for that properly is the responsibility of those who specialize in this work. Rather, the idea is to get a broad general idea of what is being done and what the general requirements for upset work are.

Having seen what already is being done for others

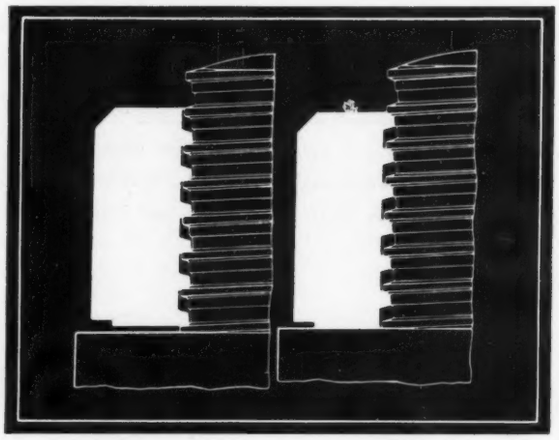


Fig. 3—Dardelet relieved thread is being rolled successfully on cold upset work

the designer will have a very much better idea of what the process may mean to his own product. If there is a new design on the board, the designer very likely will be able to modify some of the details to bring them within the scope of the process. It should be strongly emphasized, however, that definite specifying of parts—or even better yet, their actual designing—had best be done in collaboration with the development engineering department of a parts maker.

In the first place there will thus be a quick and authoritative determination of whether or not their manufacture by upsetting is practical at all, and in the second place—assuming that it is practical—certain minor changes in design may be suggested which will facilitate the making of the parts and at the same time will reduce costs and improve quality.

For the benefit of designers who have not yet visited an upsetting plant, or who may not be able to do so, there are presented herewith the several illustrations of representative single parts and of

groups of parts—some rather simple, as in *Fig.* 4, and some quite complex, as in *Figs.* 1, 2 and 5—all of which are being made by cold upsetting. The majority of them are automotive parts but a number of them might well be parts of washing machines, sewing machines, vacuum sweepers, or of the numerous other mechanisms which must be produced in large quantities and at low cost.

One of the prime differences between these upset products and those produced by other methods is that the raw material, which is wire or rod, is of the minimum diameter, or at least one of the smaller diameters, of the part instead of its largest diameter. Instead of being machined down from large diameter to the small diameters, with consequent loss of metal in chips, these parts have had their large diameters literally "blown up" from the small diameter with little or no loss of material. An

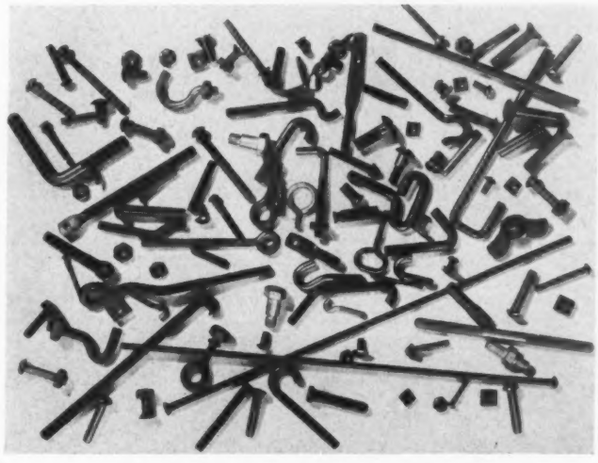


Fig. 4—Small special shapes in endless variety can be cold formed and roll threaded

excellent example of this is furnished by *Fig.* 5 on this page, which happens to be a brake detail.

In this working in the dies which ordinarily is limited to two or three quick powerful blows, the crystal structure is made to flow around the contours instead of being cut off at the corners and shoulders. Parts which are not subsequently heat treated actually do acquire a certain amount of added strength, sometimes referred to as "cold working strength," through the compacting effect in the dies. Incidentally, stock to be cold worked must be free from imperfections either surface or internal and any such imperfections are immediately brought to light when the operations are carried out. Faulty parts thus "eliminate themselves" so to speak.

While it is difficult to say definitely just what and how much a machine designer should know about cold upsetting, here are some rather important points. In the first place he should bear in mind that the work usually starts with a blank not

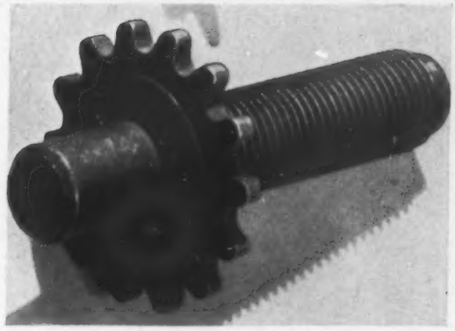


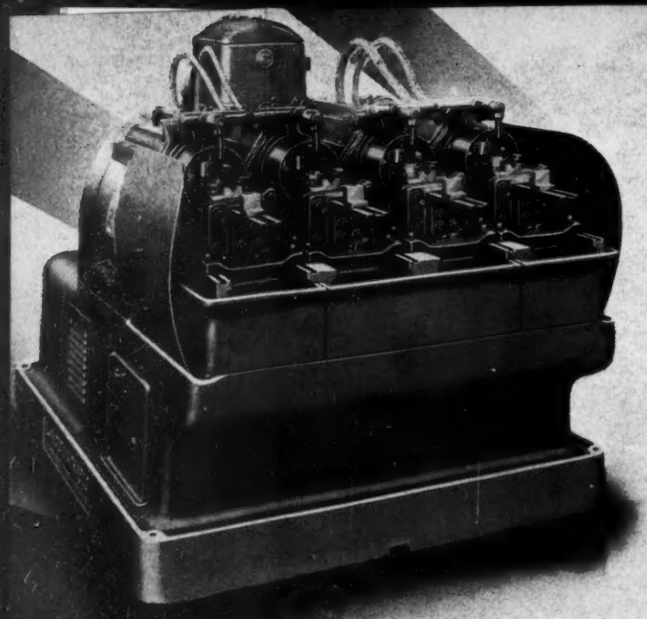
Fig. 5—Brake adjusting member, including its teeth, is a product of two-blow heading

over 10 inches long by ¾-inch in diameter. There are cases where some longer blanks are handled and rod up to 1 inch in diameter is being worked successfully but the exceptionally large equipment required for such large work is not common. By what is known as "two-blow heading," which is a normal process, diameters can be raised to 3½ times the original wire or rod diameter, and by a secondary or "reheading" operation they can be raised to twice that amount. The part shown in *Fig.* 5 is a two-blow job, including the cutting of the teeth.

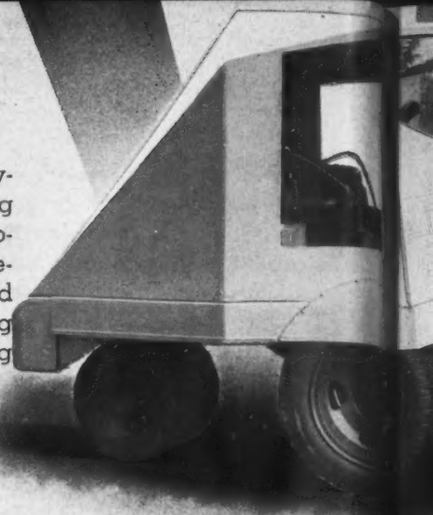
In designing for cold upsetting, as in any other work, tolerances should not be specified any closer than actually are demanded by practical requirements. Surprisingly close tolerances actually can be achieved in cold upsetting, and they will hold throughout the life of the dies, but where they are not required they only serve to increase cost unduly. Unnecessary angles and sharp corners are well avoided not only because they are "stress raisers" but also because they increase die costs. Small radii are desirable at corners and angles, but if it is not obligatory that they be exact, be sure to indicate that they are merely fillets.

Bear in mind that in connection with cold upsetting, clean, smooth and accurate threads of nearly all shapes and sizes can be produced on the parts by rolling between dies. As an outstanding example of such thread rolling, consider the recently developed Dardelet "relieved" thread. This unique thread, which is shown diagrammatically by *Fig.* 3 on Page 44, both in its unlocked (left) and locked (right) positions, approximates a Class 2 fit when in unlocked condition and a Class 5 fit in locked condition. Speaking of threads, designers should not make that all too common and costly mistake of specifying them in too high a class. For example, don't specify No. 5 or 6 fit where No. 3 is good enough.

In the preparation of this article the writer has had the benefit of advice and help from A. E. R. Peterka, technical assistant to the vice president of The Lamson & Sessions Co. To that company, as well as to the Dardelet Threadlock Corp., credit is due for illustrations which appear herewith.



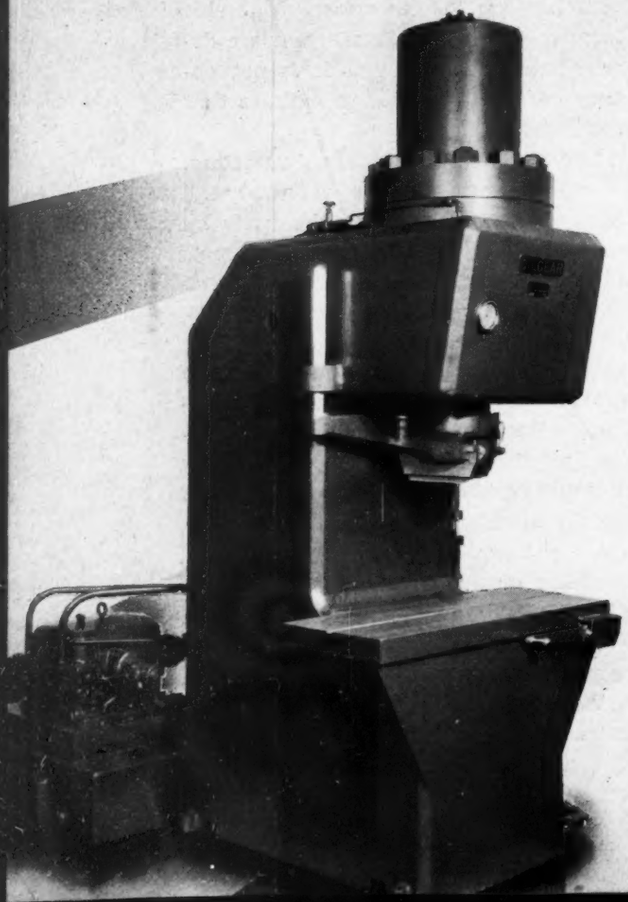
Four-spindle Landis threading machine, above, is of semiautomatic type in which movement of die head spindles and opening of the grips are actuated by cams. Unusual compactness is accomplished by designing die head spindles close together, relieving operator of need for moving from position to position



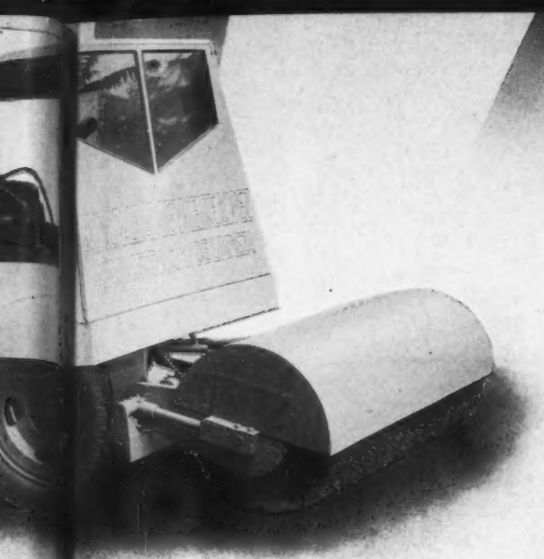
Motor, transmission and rear driving axle of the Howell sweeping machine, right, are standard automotive units allowing for easy repair. Six tires are used to spread load over large area, permitting use of sweeper on fragile paving or floors

Electric dishwasher and mechanical garbage disposal unit are combined in the General Electric kitchen sink, above. Vitreous enamel tub and chrome-plated brass trays are used to prevent rust in dishwasher. Refuse is shredded to thin pulp by Carboloy blades in disposal unit

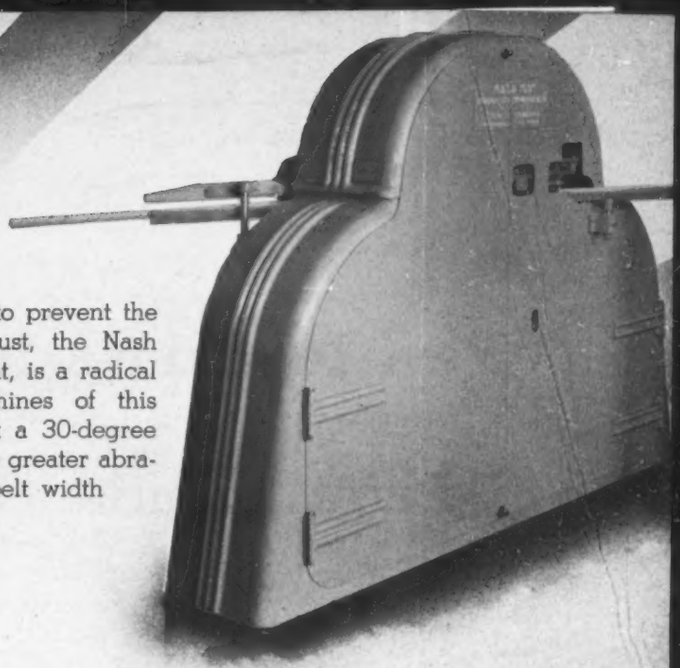
All-welded plates are used in the fabrication of the 200-ton Oilgear straightening press, below. Ground and polished press ram is fitted with molded packing and is guided in a yoke liner with extra long bronze bushing



Glass or stainless steel is used for tank lining of the Glascote pasteurizer, right. Solid cork evenly applied around the tank jacket serves for insulation. Agitator of three-blade design gives maximum of smooth and powerful agitation without danger of foaming and churning

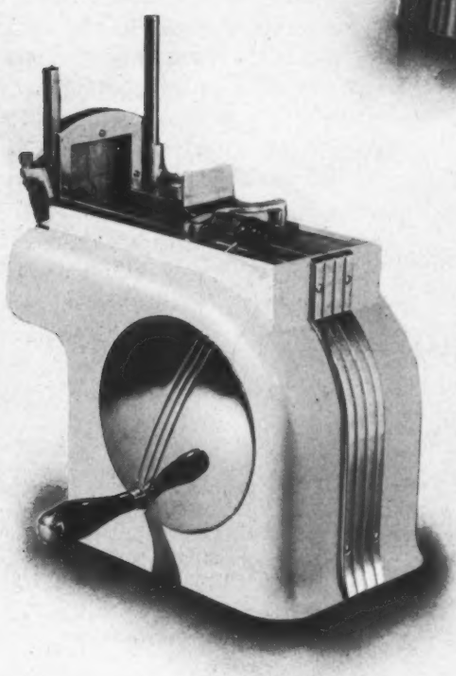


Completely enclosed to prevent the escape of abrasive dust, the Nash automatic sander, right, is a radical departure from machines of this type. Stock is fed at a 30-degree angle to belt, allowing greater abrasive contact for belt width



Design Features In New Machines

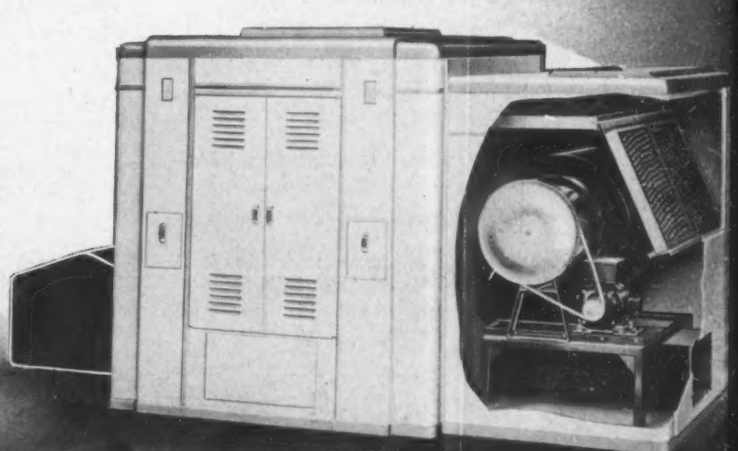
A Pictorial Presentation of Recent Machinery from the Standpoint of Design



Butter cutter, left, styled by Barnes & Reinecke for Strite-Anderson Mfg. Co. is finished in butter-colored porcelain enamel and has a chrome disk handle. A black plastic knob operates the tray-return lever. Mechanism of the return has been simplified to reduce operating motion 50 per cent

Ironing shoe of the Norge press ironer, above, is of polished aluminum with split heating element and double thermostatic control. Operating control is provided with two handles, one to raise and lower shoe and the other to apply pressure

Both rivets and welding are used to insure a leakproof drum in the stoker fired, Sunbeam air conditioner, below. Outside cabinet is made of No. 20 gage steel finished in glossy, green baked enamel. Blower and air filters are entirely enclosed in extension of cabinet



New Machines Indicate Design Trends

NEARLY 20 years ago the American Standards Association selected power presses as one of the important subjects for a safety code. First edition of this code was published in 1926, and it presented a crystallization of accumulated industrial experience that continues to serve admirably as a guide for operating and design executives as well as for state authorities. In the following years other types of machines have been discussed and rules laid down to guard the operator from accident. Designers today realize that safety is as important as any other single factor. To build a machine that does not have safety features is almost as bad as forgetting a lubrication system. To prevent injuries, two points should never be forgotten. First make it *unnecessary,* and second make it *impossible,* for an operator to place his hands or any part of his body within the danger zone.

Air Conditioning

Self-cleaning air filter, Independent Air Filter Co., Chicago.
Air conditioning unit, Westinghouse Electric & Mfg. Co., Pittsburgh.

Brewery

Bottle washer, Heil Co., Milwaukee, Wis.
Glass-lined yeast washer, Pfaudler Co., Rochester, N. Y.
Rotary filler and crowner, Crown Cork & Seal Co., Baltimore, Md.

Business

Parcel post scale, International Business Machines Corp., New York.
Register, Egry Register Co., Dayton, O.

Conveying

Vibratory feeder, Syntron Co., Homer City, Pa.

Dairy

Milk cooler, M. L. Crouch, Chicago.

Domestic

Electric refrigerator, Barlow & Seelig Mfg. Co., Ripon, Wis.
Chairside radio, Crosley Radio Corp., Cincinnati, O.
Electric hand vacuum cleaner, Electric Vacuum Cleaner Co., Cleveland.
Bathroom scales, Landers, Frary & Clark, New Britain, Conn.
Kitchen scale, Sears, Roebuck & Co., Chicago.
Burner-boiler unit, Fluid Heat Div., Anchor Post Fence Co., Baltimore.
Electric coffee mill, Hobart Mfg. Co., Troy, O.
Electric ranges, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Excavating

Heavy-duty digger and loader, Trackson Co., North Milwaukee, Wis.
Convertible excavator, Bucyrus-Erie Co., South Milwaukee, Wis.
Shovel, Thew Shovel Co., Lorain, O.
Heavy duty excavator, Harnischfeger Corp., Milwaukee, Wis.

Finishing

Vacuum extrusion unit, Bonnot Co., Canton, O.
Rotary spray-finishing machine, The DeVilbiss Co., Toledo, O.
Bumper polishing and buffing machine, Excelsior Tool & Machine Co., East St. Louis, Ill.

Metalworking

Automatic rack shaper, Fellows Gear Shaper Co., Springfield, Vt.
Cutter-grinder, Union Twist Drill Co., Athol, Mass.
Electric grinder, James Clark Jr. Electric Co., Louisville, Ky.
Hydraulic die casting machine, Kux-Lohner Machine Co., Chicago.
Internal precision grinding machine, Wicaco Machine Corp., Philadelphia.
Straight side press, Zeh & Hahnemann, Newark, N. J.
Threading machine, Geometric Tool Co., New Haven, Conn.
Electric turret lathe, Bardons & Oliver Inc., Cleveland.

Packaging

Filling machine, Frazier & Son, Belleville, N. J.
All-purpose filler, Triangle Package Machinery Co., Chicago.

Plastic

Automatic hydraulic molding press, Lake Erie Engineering Corp., Buffalo, N. Y.

Rubber

Abrader with dash pot, Henry L. Scott Co., Providence, R. I.
Rubber heel machine, J. W. Moore Machinery Corp., Everett, Mass.
Light-duty extruder, John Royle & Sons, Paterson, N. J.
Plasticator, Farrell-Birmingham Co., Ansonia, Conn.
Rubber vulcanizing press, National Rubber Machinery Co., Akron, O.

Textile

Bobbin stripper, Terrell Machine Co., Charlotte, N. C.
Double embossing machine, Van Vlaanderen Machine Co., Paterson, N. J.

Woodworking

Planer, Crescent Machine Co., Leetonia, O.
Single surface planer, Oliver Machinery Co., Grand Rapids, Mich.

Greater Unification Means Greater Recognition and Strength

WILL the end of 1938 see the engineering profession any nearer to unity? It should. There is crying need for harmony, co-operation and mutual goodwill among individual engineers and their societies, to the end that the status of the engineer may be raised to a level at least commensurate with the training, experience and general qualifications required of every member of the profession.

Fortunately this subject is now receiving more of the attention it deserves. In most places where engineers gather one hears discussions of the advantages to be gained from closer cohesion between the many and varied branches of the profession. Past-president Herron of the American Society of Mechanical Engineers, for instance, in an address at the recent annual meeting of that society, drew attention to the strong unification in both the American Medical association and the American Bar association, and stated his firm conviction that engineers should "get together" in the same or a somewhat similar manner.

In many ways—socially, technically and economically—engineers of all types are interdependent, and the sooner this is realized by the more aggressive individuals and associations throughout the country, the sooner will the work of the engineer become even more effective and the standing of the entire profession be raised.

• • •

Drives and Controls

VARIOUS phases of design upon which emphasis will undoubtedly be placed during the coming year are a continuance of the trend toward the building-in of parts and "streamlining," the utilization of special fastenings including new types of screws, greater use of plastic parts, elimination of noise and vibration, and the more widespread adoption of electrical control and operation.

Progressive designers in different parts of the country are giving particular attention at this time to the last-named—electrical—method of operation. Machines have been powered by individual motors (as many as ten or more in some cases) for years; now, however, not only the drives but also other sections of the machine or the operations thereof are becoming "all-electric."

It is to bring these developments to the forefront that MACHINE DESIGN is planning a supplement on "Machine Drives and Controls" for inclusion in the forthcoming April issue. In its make-up the supplement will be similar to the one published with the April, 1937, issue; the supplement will, however, emphasize more fully the utilization of all types of controls, as well as covering the latest developments in driving methods.

Designing Plastic Parts from Production Standpoint

(*Concluded from Page* 39)

brittle, substantial walls are required for adequate mechanical strength. Added strength may be obtained by reinforcing wide thin areas by ribs. This feature is illustrated in *Fig.* 5. The ribs not only provide strength, but they also act as feeders or gates for the material. Besides, economy of material is realized through the elimination of heavy sections. The molding cycle also is shortened by using thin, ribbed sections because the time for curing is decreased.

UNDERCUTS AND OBLIQUE HOLES—As a rule, undercuts and oblique holes should be avoided in the design of the molded parts. In certain instances, when mold cores or special polished inserts may be removed from the molded piece, undercuts and oblique holes are possible, but for average design they are impractical. The same thought applies to long or very thin horizontal holes. It will often be found more economical to drill these holes rather than depend upon a complicated molding operation.

SHARP CORNERS AND RECESSES—Generous radii and fillets overcome structural weaknesses in sharp corners on molded parts and incidentally improve the general appearance. The plastic flow of the molding material is also aided by these procedures, inasmuch as sluggishness is alleviated and the mold is more completely filled. On the outside, sharp recesses tend to collect dust and are not easily cleaned unless designed with ample radii.

Letters on Plastics Should Be in Relief

MISCELLANEOUS—There are a large number of precautions of which the machine designer should be aware in designing molded parts. Space will not permit amplification of these details though a few miscellaneous instances have been cited. Others that may be noted include lettering and engraving. Letters on the molded part should stand out in relief. This means a simple engraving operation on the mold and not the costly procedure that intaglio lettering would require.

Another example of increased strength in a molded part is exemplified by the following illustration. A cross section of a handle with two inserts (shown in *Fig.* 6) was subject to frequent breaking at the indicated section. By redesigning the part to make the end of the insert terminate a short distance above the center of cavity, the breakage was minimized. Similar applications of the fundamental principles of the strength of materials will go a long way toward improving molded parts for production.

When the number of plastic parts required is limited it may not be feasible to invest in a mold. The manufacturer then may rely upon the machining of cast or laminated parts for his supply. Careful buffing and polishing operations will restore a high lustre to the surfaces that have been machined. Cast plastics are particularly valuable as a decorative article. They are available in a large assortment of colors and in bar, rod and tube stock. The cast phenolics are often cast to final form in a multiple cavity mold with no further operations than buffing to remove the flash and a minimum of machining. These methods are often employed on small decorative parts, bushings and washers. Rods are available in sizes from ¼ to 5 inches in diameter. Sheets of cast phenolics are also prepared by special methods.

Laminated Stock Often Machined

The machining of laminated stock for production items is not uncommon, especially where the high strength of the laminated plastics may be utilized to good advantage. Tooling for such machining operations differs from that employed for the different types of metals. The phenolic plastic clings to the flutes and grooves and the tool tends to run hot unless proper production tools for machining plastics are used. Besides, as pointed out before, the drilled holes run undersize, due to the inherent resiliency and springiness of the plastic surface. However, when one becomes familiar with the machining qualities and peculiarities of the nonmetallic substances difficulties appear less frequently.

In conclusion, the importance of utilizing the correct plastic terminology and specifications should be emphasized because the design of plastic parts for production merits more than casual treatment. It will likewise be observed that the intelligent and ingenious utilization of metal inserts will greatly facilitate the assembly of parts in the proposed machine.

New Heating for Molds and Presses

Among the outstanding features of the new plant of the plastics division of General Electric Co., Pittsfield, Mass., at which all plastic activities of the company have now been consolidated, is the heating system for the molds and presses. This provides heat through hot water under pressure rather than through the usual steam system. The hot water is supplied at a pressure of about 190 pounds per square inch at a temperature of 370 degrees Fahr. This causes the water to travel at a rapid rate throughout the press room and through all molds, giving extremely uniform distribution. Water returns to the boiler at a temperature only about ten degrees lower than that at which it leaves the pump.

Men of Machines

TRANSFER of John Flodin from the New York Navy Yard to the Navy Department, Washington, brings an advancement to an engineer who has had wide practical experience in ship construction—his work throughout the years ranging in naval ships, from submarines and destroyers to giant airplane carriers, and in merchant ships, from harbor craft to ocean liners. This appointment marks the resumption of the Navy's program to study, classify and standardize toothed and worm gearing as applied to ship machinery. Mr. Flodin will represent the Bureau of Construction and Repair in his work, in addition to his other duties.

His formal education was received at the Universities of California, Washington and Minnesota, where he earned degrees of B. S., M. E., M. S., and M. A. He taught machine design at the last-named institution.

JOHN FLODIN

• • •

D. ROBERT YARNALL

D ROBERT YARNALL, chief engineer of Yarnall-Waring Co., Philadelphia, has recently been elected president of United Engineering Trustees, joint agency of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

A native of Delaware county, Penna., Mr. Yarnall graduated with a bachelor of science degree from the University of Pennsylvania in 1905. From 1902 to 1907 he was associated with Coatesville Boiler Works, after which he joined Stokes & Smith Co. Later he became vice president and general manager of Nelson Valve Co. In 1912 he organized the Yarnall-Waring Co. Mr. Yarnall is director and chairman of the public affairs committee of the American Engineering council.

• • •

APPOINTMENT of Henry Clay Anderson, formerly professor of mechanical engineering and head of the mechanical engineering department, as dean of the college of engineering, University of Michigan, was recently announced.

Dean Anderson's practical experience began in 1897, after graduating with a degree of bachelor of mechanical engineering from the University of Kentucky. After four years in a railroad shop as an apprentice learning the machinist trade, he became assistant to the master mechanic of that railroad. In 1900 he was appointed instructor in mechanical engineering, University of Michigan, then successively assistant professor, junior professor, professor, and finally in 1917 to the position he held until his present appointment. His professional work in the field of engineering ex-

HENRY C. ANDERSON

tends over a period of nearly forty years. In addition to his connection with the faculty of the university, Dean Anderson was, for a number of years, a member of Brush, Allan and Anderson, Detroit, now known as Brush, Ammerman and Anderson, engaged in general engineering practice.

Born Dec. 4, 1872, in Morganfield, Ky., Dean Anderson's early years were spent on a farm. His education was obtained in country schools of Union County, Ky., in Morganfield Academy (connected with the University of Kentucky) and at the University of Kentucky.

♦ ♦ ♦

MERRILL N. DAVIS, executive vice president and secretary of S. R. Dresser Mfg. Co., Bradford, Pa., has been elected president of the Association of Gas Appliance and Equipment Manufacturers.

♦ ♦ ♦

D. HAYES MURPHY, president of the Wire Mold Co., Hartford, Conn., was recently elected president of the National Electrical Manufacturers association.

♦ ♦ ♦

E. G. BAILEY, vice president of the Babcock & Wilcox Co., New York, and president of the Bailey Meter Co., Cleveland, has been given the honorary degree of Doctor of Engineering by Lehigh university for "notable and distinguished accomplishment in the field of combustion and steam engineering."

♦ ♦ ♦

F. E. HODEK JR., of General Porcelain Enameling & Mfg. Co., has been named president of the Porcelain Enamel institute, and RICHARD H. TURK, of Porcelain Enamel & Mfg. Co., vice president in charge of research.

♦ ♦ ♦

HOWARD DUNBAR of Worcester, Mass., has been elected president of the National Machine Tool Builders association.

♦ ♦ ♦

J. M. FERNALD, vice president and general manager, Baker Ice Machine Co., Omaha, Nebr., has been re-elected president of the Refrigerating Machinery association. A. H. BAER, general sales manager, Carbondale division, Worthington Pump & Machinery Corp., Harrison, N. J., was re-elected first vice president, and WILLIAM B. HENDERSON, Washington, executive vice president.

♦ ♦ ♦

HAROLD W. ZIPP has been appointed chief engineer of the Stearman Aircraft Co., Wichita, Kansas.

♦ ♦ ♦

D. T. DOWNES, chief engineer, Calorizing Co., Wilkinsburg, Pa., has resigned to accept a position as development engineer for Pittsburgh Plate Glass Co., at the recently organized central development laboratory.

♦ ♦ ♦

CHARLES W. RAUCH has recently been appointed advertising manager of Marlin-Rockwell Corp., Jamestown, N. Y. Mr. Rauch has been identified with the company for the past twenty years, the first ten years of which he served in the engineering department in capacities of designer, chief draftsman, sales engineer and consulting engineer.

♦ ♦ ♦

PHIL HUBER, formerly vice president and assistant general manager, has been elected president and general manager of Ex-Cell-O Corp., Detroit.

♦ ♦ ♦

L. W. WALLACE, head of engineering research for the Association of American Railroads, has been named director of the new division of engineering and research recently formed by Crane Co., Chicago, which will co-ordinate all engineering activities of the company.

♦ ♦ ♦

GEORGE T. CHAPMAN has become associated with the Eaton Mfg. Co., Spring Division, Detroit, where he is in charge of machine development engineering.

♦ ♦ ♦

F. G. WACKER, president of Automotive Maintenance Machinery Co., North Chicago, Ill., was recently confirmed as president of the Motor and Equipment Manufacturers' association.

♦ ♦ ♦

EDWARD A. JOHNSTON has been selected by the jury of awards of the American Society of Agricultural Engineers as the recipient of the society's 1938 Cyrus Hall McCormick medal for "exceptional and meritorious engineering achievement in agriculture." Mr. Johnston is vice president in charge of patents and engineering of International Harvester Co.

Obituaries

HOWARD E. COFFIN, 64, industrialist and former automobile manufacturer, died recently at Brunswick, Ga., of an accidental gun shot. Mr. Coffin rose to eminence in three major American industries: He was founder of Hudson Motor Car Co., was responsible for development of the Liberty motor, and was founder and first president of National Air Transport Inc. Since 1932 he had been active in the textile industry in the south, and was chairman of the board of Southeastern Cottons Inc., at the time of his death.

♦ ♦ ♦

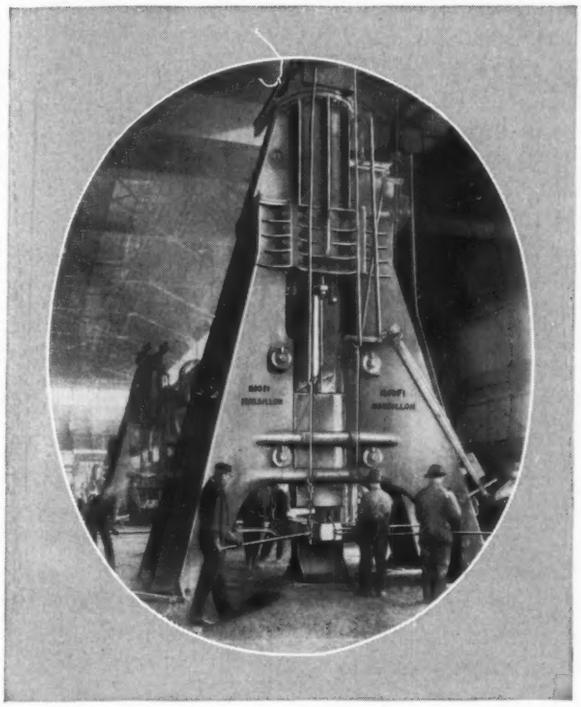
FRANK H. SLEEPER, president of Sleeper & Hartley Inc., Worcester, Mass., builders of spring-making machinery, died recently. Mr. Sleeper designed and built many spring-making machines for companies in Canada and had more than 300 patents to his credit.

♦ ♦ ♦

DR. GARDNER C. ANTHONY, dean emeritus of the Tufts Engineering school, died at New Rochelle, N. Y., on Nov. 29, at the age of 80. He was a former director of the mechanical department of Rhode Island School of Design and founder of the Rhode Island Technical Drawing School of Providence.

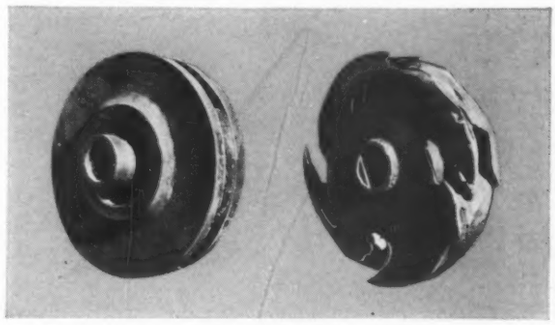
PROFITS *leak through many a loophole*

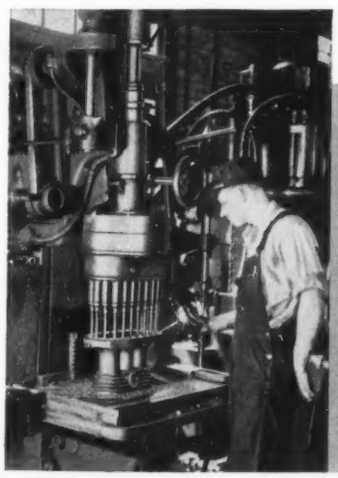
NICKEL CAN EASILY PLUG



MACHINERY repairs and replacements often run higher than you anticipate—often throw you for a *loss* when you are expecting to make a *gain*. Frequently, time lost when machines are out of action, may be far more costly than the expense of making the repairs themselves. But when equipment is fortified at vulnerable points with strong, tough alloys of Nickel, service records often stretch for astonishingly long periods. At left, a forging hammer illustrates the point. Located in a large Ohio Valley plant, it has bushings of Nickel alloy iron, produced by the Continental Roll and Steel Foundry Company. Because of wear in the bore it was recently decided to replace these bushings. When the records were looked up it was found that they had served for *ten years*. Bushings of the same composition had also served another hammer in the same plant for *twelve years*. Hence, when the new order was placed the same producer was asked to duplicate the original composition of Nickel cast iron. A record, demonstrating the need for keeping a record.

BEFORE and after — what happens to plain white cast iron impellers operating in pumps handling highly abrasive material consisting of 73% solid matter. Failure at the end of 551 hours was the average record of eight of these impellers. Yet, operating under identical service conditions, six NI-HARD* Nickel-chromium cast iron impellers demonstrated an average life of 1319 hours, a ratio of 2.39 to 1 in favor of NI-HARD. These results were obtained from records compiled at the Copper Cliff, Ontario, operations of The International Nickel Co., Inc.





UNDER the high-speed multiple drill pictured at the left is a compressor cylinder destined for use in refrigeration apparatus made by the York (Pa.) Ice Machinery Corporation. Among the requirements that must be met by a metal for this service are pressure-tightness, high wear-resistance and ease of machinability. All of these are supplied by Nickel cast iron, hence this is the material used by York for cylinders, top heads, pistons, crankcases and bearing heads. The company states that these parts in which Nickel is used *have never yet required replacing because of wear.* We invite consultation on the use of the alloys of Nickel in your equipment.

* NI-HARD—Reg. U. S. Pat. Off. by The International Nickel Co.— Canadian Patent No. 281,986.

NICKEL CAST IRONS

THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK, N. Y.

Assets to the Bookcase

Machine Design

By P. H. Hyland and J. B. Kommers; published by the McGraw-Hill Book Co. Inc., New York; available through MACHINE DESIGN *for* $4.50, *postpaid.*

This is the second edition of a justly popular text book, of which the first edition was reviewed to some length in the December, 1929, issue of MACHINE DESIGN. While written primarily for use in teaching the elements of machine design in college, this book can be highly recommended for home study by beginners who want to become designers and by older men who want to review their theory and to catch up with recent developments. Incidentally the book is well worth keeping in the drawer of the drafting table or the engineer's desk as a practical work of reference.

The authors, who are respectively associate professor of machine design and professor of mechanics at the University of Wisconsin, turned to industry for help and suggestions in their work of revision. As a result this second edition ties in closely with modern industrial developments in machine design practice.

□ □ □

Inventions and Their Protection

By George V. Woodling; published by the Penton Publishing Co., Cleveland; available through MACHINE DESIGN *for* $5.00, *postpaid.*

Here is a book of extraordinary interest and value to engineers and designers because it provides a ready means for understanding how an invention is clothed with the legal protection necessary to enhance its economic value. From this clear and concise treatise the average reader should gain a more accurate conception of the patent system than from any work heretofore available.

The book does not befog the mind with a mass of legal terms, for the language employed is as nontechnical as the technical character of the subject permits. The text is clear, concise and easily understandable. There is not a mystifying term used in the entire 16 chapters covering 316 pages.

Mr. Woodling writes both from the practical and legal sides, he being an engineer as well as a patent attorney. In the book he has taken certain questions which have confronted him in his daily practice in each field and has interwoven them into the text in such a way as to give it a flavor of simplicity and practicability. Some of the material has been used in Mr. Woodling's effective series of articles in MACHINE DESIGN.

Numerous charts and diagrams enable the reader to follow the course taken by an ordinary patented device from the date of its conception to the time when it receives the protection of letters patent. A supplementary chapter deals with trademarks in all their ramifications.

This is a book which engineers and designers will come to depend upon in their daily work, fulfilling as it does the long-felt need for a treatise that gives a practical knowledge of patents. How are patent disclosures prepared? How are rights to invention as between employer and employe determined? What are the requirements of patentability with reference to patenting new developments? What is a good analysis of patent claims in designing noninfringing devices? The reader will have no difficulty in finding a satisfying answer to these and numerous other questions pertaining to inventions and their protection.

□ □ □

Symposium on Wear of Metals

Sponsored by the Philadelphia district committee, ASTM; published by the American Society for Testing Materials, Philadelphia; available through MACHINE DESIGN *for* $1.25, *postpaid.*

The 105 pages of this book carry a large fund of theoretical and practical information regarding wear of metals in various kinds of machinery and equipment. Methods of eliminating or reducing such wear through proper design, lubrication and selection of materials are set forth in such a manner as to be decidedly useful to mechanical engineers and designers.

As a symposium the text is made up of six papers, together with an introduction and discussions. Subjects covered are: Wear testing of metals; variables in cast iron wear tests; and metallic wear from the automotive, power equipment, textile machinery and railroad viewpoints. Authors of these papers, are respectively: H. W. Gillett, D. E. Ackerman, W. E. Jominy, N. L. Mochel, Albert Palmer, and L. W. Wallace. Introduction and closing discussions are by G. H. Clamer. These men are well known to many readers of MACHINE DESIGN as authorities in their chosen fields.

Supplementing the text are numerous photographs, diagrams, graphs and tables. Also included is a seven-page bibliography comprising 137 items, American, British and European.

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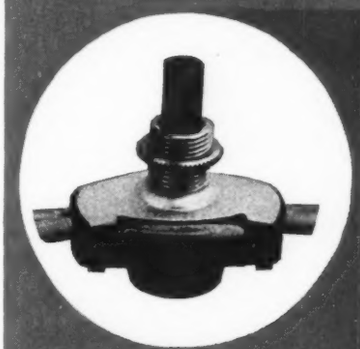
A neat three-speed fan switch—ideal for controlling two- or three-speed fans. Bakelite handle of modern design. Convenient nozzle mounting. Rugged mechanism insures long life and satisfactory service.



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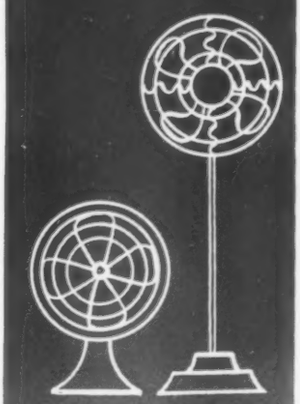
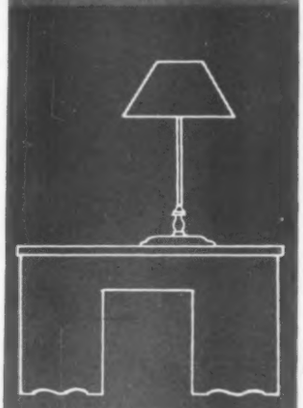
Take advantage of the wide variety of G-E appliance control switches — or consult G-E Accessory engineers if your problem requires specialized attention. Custom service is always at your disposal.

For information, write to Section Q-8341, Appliance and Merchandise Department, General Electric Company, Bridgeport, Conn.





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APPLIANCE AND MERCHANDISE DEPARTMENT,
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● Wilco Thermometal is the least expensive method of automatically producing power and motion because it eliminates the necessity for auxiliary impetus.

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These factors of superiority are due to The H. A. Wilson Company's undeviating standards of excellence to which it has adhered for more than two decades.

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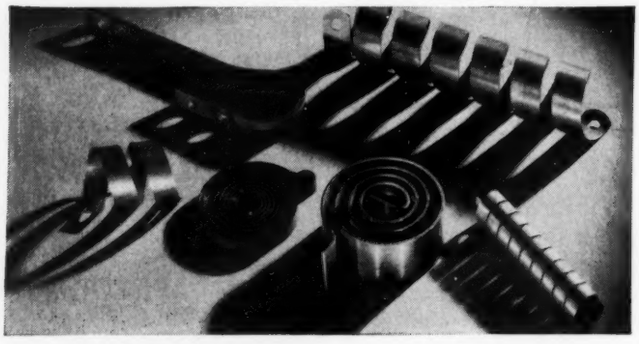

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Noteworthy Patents

FEEDING of sheets of paper successively from the bottom of a stack and their delivery to a desired point by a simple and reliable means, are the primary objects of a mechanism covered by patent No. 2,082,064. This patent has been granted to Paul E. Kleinberg of Easton, Pa., and assigned to T. W. & C. B. Sheridan Co. of New York.

A sectional diagram of some of the principal parts of this mechanism in action appears herewith as *Fig.* 1. The sheets, or signatures, are handled from two opposite edges or ends, so that detachment and downward separation of the lower sheet in the upper stack is remote from the extraction and delivery thereof, thus avoiding conflicting mechanisms.

While the body of the stack rests on an underneath supporting plate, its left end is free from this plate, the extreme left edge resting on a supplemental support which deflects the ends of the sheets in an upward curve. Below the right-hand end of the stack is a suction device by which a sheet can be caught and pulled down at that end, enabling a gripper finger to snap down over it. The gripper mechanism then rocks toward the right, thus pulling the sheet off its support at the left hand end.

Timing of the transfer drum is such that just at that moment one of the two cam-operated grippers on this drum seizes the left end of the sheet as it drops away

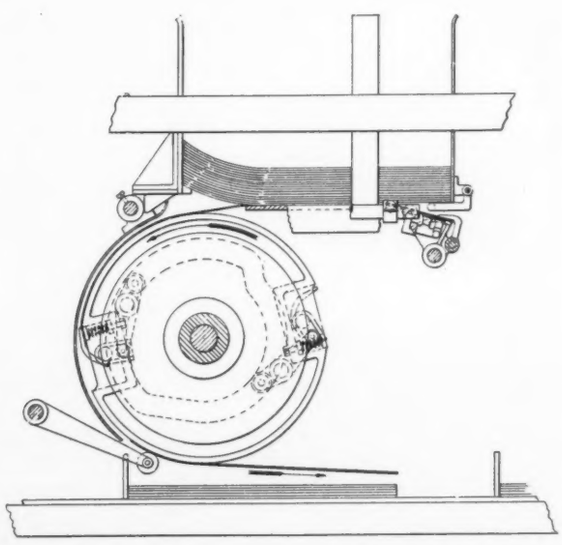
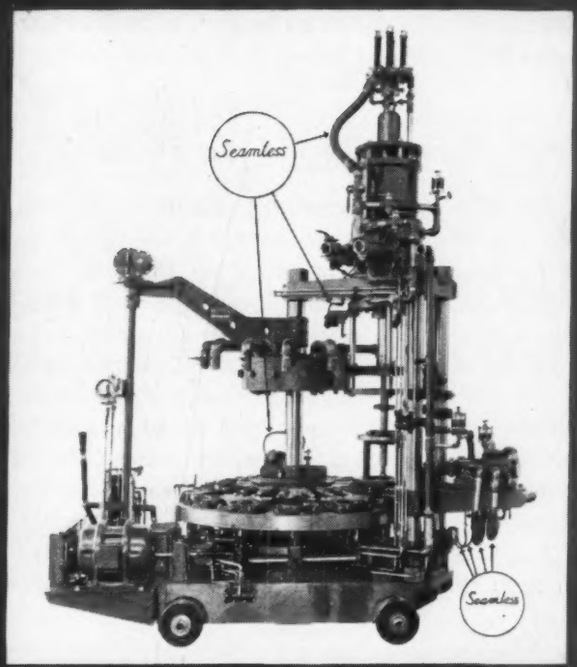
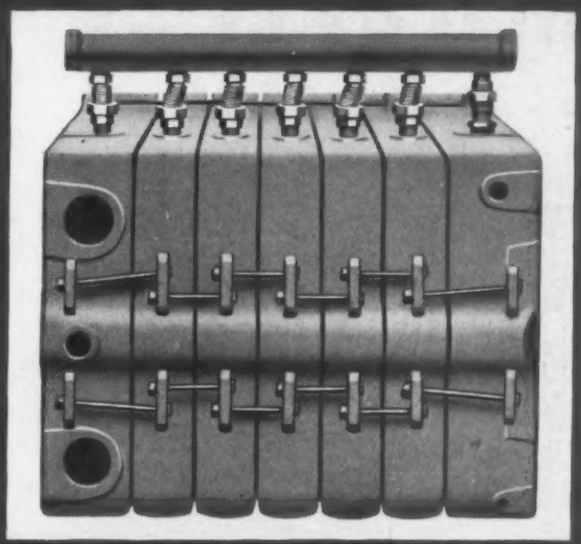


Fig. 1—*This mechanism removes sheets from bottom of a stack and delivers them to a conveyor*



Flexible American Seamless is used for airlines on Lynch Bottlers.



The Burnham Boiler Corporation of Irvington, New York, furnishes these Flexible Connectors to dealers, when they are faced with tappings that do not line up.

For Boilers or Bottlers or Smart Cord Cars!

American Metal Hose fills the bill...

wherever flexible connectors are needed

American stainless steel tubing exhaust covering on the new Cord. Photo courtesy of the Auburn Automobile Company.

Illustrated are but three of the countless uses of American Flexible Metal Hose and Tubing. Wherever the conveyance of steam, oil, air, or water offers a problem...wherever vibration menaces rigid piping...wherever there is need of a safe connector between two moving parts ...the "American" way is the solution.

Incorporating these leakproof, flexible connectors as an original part is a guarantee against future trouble—repairs, delay, and costly breakdowns. Maintenance engineers in steel mills, textile factories, chemical and glass plants, automotive and metal manufactories testify to the ability of American Seamless to withstand the most severe working conditions.

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Brute force does not strip or round out Bristo Cap and Set Screws. Of the performance-proved multiple spline socket design, Bristos permit a much T-I-G-H-T-E-R set-up with no danger of loosening in tough service. Write for Bulletin 83-3N today. The Bristol Company, Mill Supplies Division, Waterbury, Connecticut.

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Multiple Spline

SET AND CAP SCREWS

from its support. At the same instant the previously mentioned oscillating gripper at the right of the stack releases its hold, allowing the sheet to be drawn from under the stack and around the transfer drum.

New Form of Gear Pump

TO THE many varieties of rolling rotors used for pumping, there now is added a new type invented by Arthur J. Northey of Parkstone, England. His patent—No. 2,097,037—has been assigned to Northey Rotary Engines, Ltd. of Townsville, Australia.

Shown in section in *Fig.* 2 is one of the embodiments of this invention, of which several different forms are possible. The design lends itself to application as an air or gas compressor, a vacuum pump or a liquid pump. The one illustrated is a water-jacketed compressor.

The rotors, which are geared together externally to keep them exactly in step with each other, are

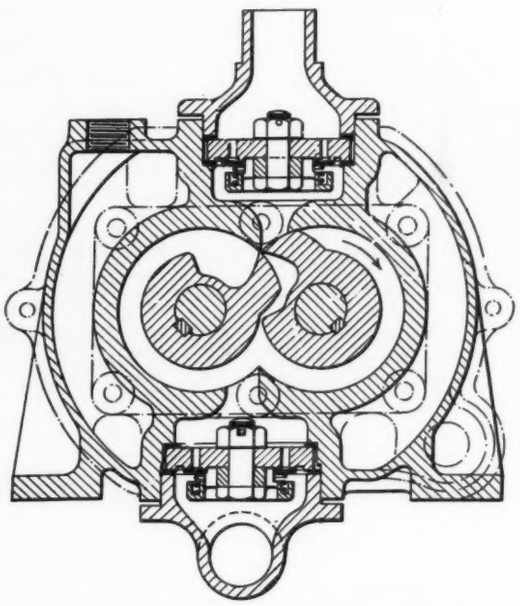


Fig. 2—Pumping action is attained by rotors with single hook-shaped blades

cylindrical except for one peculiar shaped tooth or blade and an adjoining recess, on the periphery of each. As the rotors revolve in opposite directions, rolling on each other, their curved teeth sweep around within the intersecting bores in the casing, against which they are a running fit. The right hand rotor, which turns clockwise, does the driving.

The end of the compression stroke is reached when the blades arrive at a position immediately above the exhaust port. As the rotors move on from that position, the two non-return valves close automatically and remain closed until the new cycle begins.

Like Encores at an Ice Carnival

Miss Bess Ehrhardt—America's Sweetheart of the Ice — the star of the recent Sixth International Ice Carnival at the Chicago Stadium

DUMORE MOTORS GIVE YOU EXTRA PERFORMANCE

In Dumore motors you get all you pay for . . . and more ! By precision manufacturing methods perfected over a period of 25 years, Dumore motors have "plus" life *built in.* Extra hours of trouble-free power are directly due to the scientific accuracy, the dogged attention to details, and the relentless inspection on the Dumore assembly line. Pride of craftsmanship among Dumore's experienced workmen puts the stamp of up-to-the-minute refinement on every one of Dumore's Universal (AC-DC) Motors . . . 1/600 h. p. up to 3/4 h. p. . . . 0 to 60 cycles. Whether for delicate instrument controls or for heavy shop tools, each has the same remarkable precision; each is destined for a long life of brilliant performance. Typical of these vibrationless sweet-running units is the *Type HVL motor shown at the right.

Start now to get more power hours for your money. Let Dumore engineers appraise your power problem and recommend the right motor for your exact requirements. "Tailored to fit" parts take care of special adaptations. Write today for latest catalog and Engineering Service Blank.

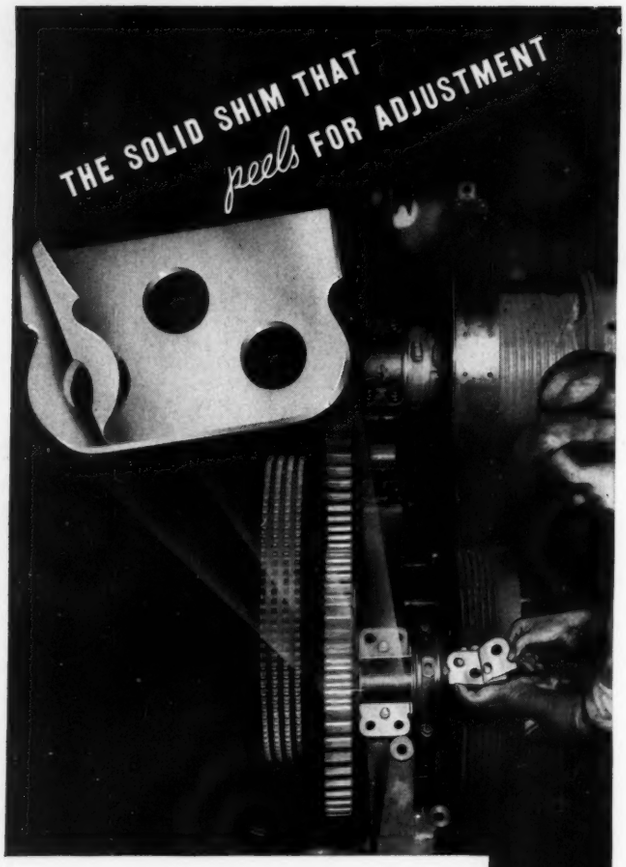
THE DUMORE CO.
Dept. 128-A Racine, Wis.

DUMORE
Silver ANNIVERSARY
1918-1938

*** Specifications Type HVL Motor**

Series (universal) 0-60 cycles; h. p. range, 1/38-1/92; full-load speeds, 929-83 r.p.m.; volts, 115; amperes, .46; watts input, 50.4; duty, continuous; temperature rise 40° C.; method of cooling, internal fan; bearings, composition bronze; motor housing material, pressed steel; gear unit housing material, die cast zinc alloy; finish, black crinkle enamel; weight, 2 lbs.

DUMORE MOTORS FOR Extra Power Hours



Courtesy of Thew Shovel Co.

in gruelling power shovel work

. . . for precision adjustment of the bearing for the power (swing) shaft of this Lorain shovel. "We also"—reports the Thew Shovel Company —"use Laminum shims in the bearings of the hoist shaft and in several other places throughout the machine where fine adjustment is necessary." Laminum sample on request.

LAMINATED SHIM CO., INC. 21-26 44th Ave., Long Island City, N.Y.
Cleveland Detroit Milwaukee
934C

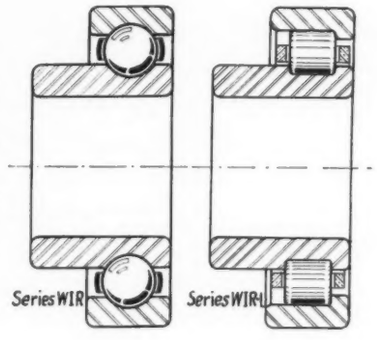
LAMINUM
Precision adjustment **SHIMS**

NEW Materials and Parts

Bearings with Wide Inner Ring

TWO new types of precision bearings, the WIR series of ball bearings and the WIR-L series of roller bearings, have been placed on the market by Norma-Hoffmann Bearings Corp., Stamford, Conn. Distinctive feature of the bearings is the use of a wide inner ring of double row bearing width in combination with an outer ring of single row width. They have been designed primarily for opposed mounting in electric motors and similar equipment. The wide inner ring insures a better sealing on the shaft

Wide inner ring of bearings insures better sealing on shaft and often avoids necessity of threading shaft to apply lock nuts

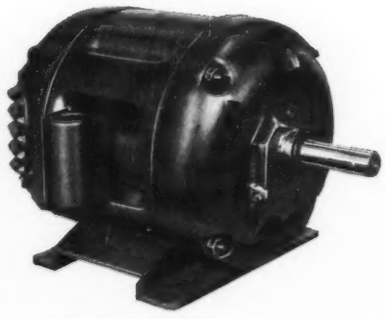


than the standard single row ring. In many cases also it avoids the necessity for threading the shaft and applying lock nuts or other locking devices. The WIR ball bearings are available in the medium metric series from 25 to 55 millimeter bore. The WIR-L roller bearings with one-lipped outer ring are available from 30 to 130 millimeter bore.

Motors Have High Starting Torque

AN IMPROVED line of integral-horsepower type RG repulsion-induction motors has been developed by Wagner Electric Corp., St. Louis. Elec-

Integral-horsepower motors have high starting torque making them ideal for compressor and pump applications



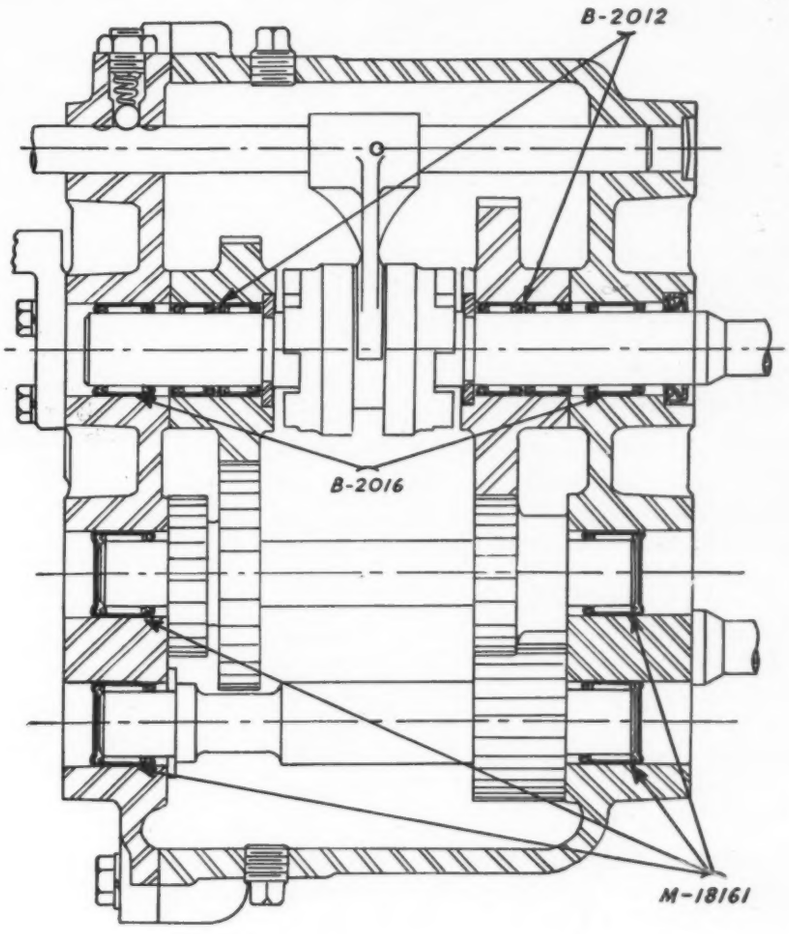
trical characteristics of these motors make them ideal for operating air compressors, viscous liquid

TORRINGTON NEEDLE BEARING

DESIGN AND SERVICE FEATURES

POWER CONTROL GEAR BOX

—a typical application where this new type anti-friction bearing offers unusual advantages.



NUMBERS ARE TORRINGTON NEEDLE BEARING CATALOG NUMBERS FOR STANDARD TYPES AND SIZES

Combining the features of an anti-friction bearing into a single compact unit that requires very small space—often less than for a simple bushing—the new Torrington Needle Bearing is ideally suited to applications of the type shown here.

In power control box installations, where there may be forty or fifty bearings required, the small size of the Torrington Needle Bearing is of utmost importance. Likewise, where as many as ten different control and power shafts are taken from one power source, high unit capacity and low friction coefficients of the Needle Bearing greatly increase the efficiency of the unit. Furthermore, the efficient lubrication of the Torrington Needle Bearing reduces costs of service and maintenance and outage for repair.

In laying out applications of this type, a careful analysis of loads should be made, as it has been found that certain of the bearings can be severely loaded, and this should be provided for in the design. The experience and cooperation of the Torrington Engineering Department are available to manufacturers interested in adapting the Torrington Needle Bearing to their product. Further information will be found in the Torrington Needle Bearing Catalog, available on request. Write for Catalog No. 9.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings

TORRINGTON
NEEDLE BEARING

SEVERAL "POOR RELATIONS"
. . . BUT ONLY ONE
AMPCO METAL
. . . DISTINGUISHED BY THIS MARK

THE luster of iron pyrites deceives us until the testing crucible reveals its true identity as "fools' gold."

Ampco Metal has several "poor relations" in non-ferrous alloys that look like Ampco, but fail dismally when tested for Ampco qualities of wear resistance—tensile strength —corrosion resistance.

There is no patent or secret covering the ingredients in Ampco Metal, but only Ampco Metal, Inc. of Milwaukee, understands the method of combining copper, aluminum and iron to produce the "Ampco Phase" . . . the particular structural formation which provides Ampco Metal with that unmatched wear resistance which has led to its adoption by hundreds of nationally prominent manufacturers.

Genuine Ampco Metal is distinguished by the diamond trade mark reproduced here. It is available only from this Company and its four licensee foundries . . . in six grades of varying hardness and physical properties. The book "Ampco Metal—Its Uses in Modern Industry" will interest you.

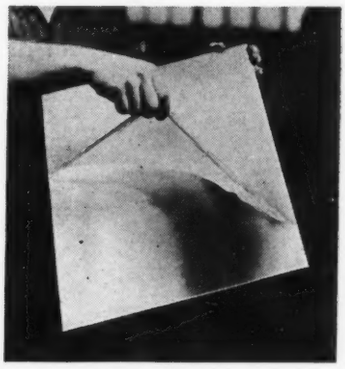
AMPCO METAL INC.
Dept. MD-1 **Milwaukee, Wis.**

AMPCO METAL
"The Metal without an Equal"
BEFORE YOU SPECIFY . . . INVESTIGATE AMPCO

pumps, conveyors, etc. Salient characteristics are high starting torque, low starting current, positive starting on low voltage, high power factor and excellent efficiency. The type RG motors are available in sizes 1 to 3 horsepower, in vertical and horizontal types.

Protective Coating Easily Applied

TEMPORARY coating which protects highly finished surfaces throughout manufacture, storage and shipment has been placed on the market by Haydn F. White & Co., 1740-M East 12th street, Cleveland. Known as Protex, it prevents the scratching or marring of stainless steel, aluminum, and



Coating forms thin, tough, elastic film which lasts until positively removed by pulling from the metal

painted or lithographed metals. Protex forms a thin, tough, elastic film which lasts until positively removed. It is applied by brushing, dipping or spraying and usually is covered with a paper backing to facilitate removal and prevent tackiness. The material is removed by peeling the film and paper from the steel. Protex is available in several types to meet particular needs. It is compounded for highly finished metal and painted or varnished surfaces.

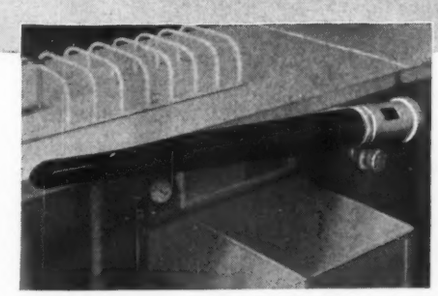
Explosion-Proof Motor Designed

DESIGNED for mounting in locations where flammable liquids, gases or other combustible fumes are present, a line of explosion-proof, squirrel

All moving parts of motor are completely enclosed and housing is strong enough to withstand internal explosion

cage, alternating current motors has been announced by The Reliance Electric & Engineering Co., 1088

1,202,240 STITCHES PER STOCKING

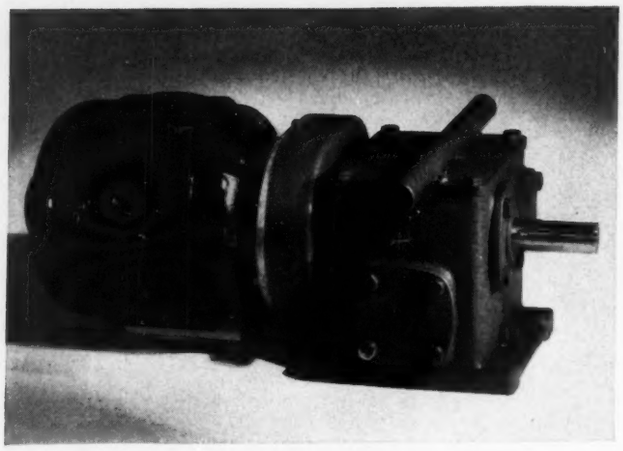


SYNTHANE makes it possible for the manufacturer to scan the 1,202,240 stitches of a sheer silk stocking in the twinkling of an eye. . . . *Synthane* Bakelite-laminated is used in stocking examiners because it has three desirable properties in *combination*—smoothness, solid color, and wear resistance. . . . You can get this same combination of properties or almost any other combination you desire in *Synthane*, for *Synthane* has an unusually broad *combination* of physical, electrical, chemical and mechanical properties. *Synthane* is a dense, solid material, tough, strong and light in weight—an excellent electric insulator—with a low power factor, low moisture absorption, high dielectric strength and low dielectric constant. It's chemically inert and corrosion resistant. It machines easily. *Synthane* is often the most *economical* material to use through lowered production costs, better product performance, dependable adherence to standards. Why not write for data on *Synthane*, giving us your requirements?

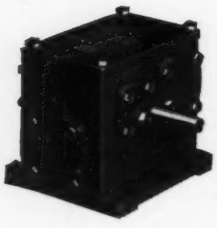
SYNTHANE CORPORATION
NORTH RIVER ROAD, OAKS, PENNSYLVANIA

SHEETS • RODS • TUBES • FABRICATED PARTS • SILENT STABILIZED GEAR MATERIAL

SYNTHANE
Bakelite— laminated



A stock gear box, a small casting and a motor . . .



The simple addition of a small housing, with two stock gears, enabled the engineers of a large machinery company to adapt a stock Ohio gear box to one of their intricate machines. Use of the standard part quite naturally cut cost substantially under that of a specially designed assembly, and—these definite advantages were gained:

1. They avoided heavy tooling expense.
2. They escaped inventories and investment in parts.
3. They purchase only as required yet enjoy lowest cost.
4. They insure customers' quick replacement.

Ohio stock gears and boxes may offer interesting advantages and substantial economies in the design and construction of your own products. You'll find them easily adaptable and Ohio Gear engineers ready to cooperate with you. Send for our new, complete catalog and information. Consult the nearest representative or write direct.

THE OHIO GEAR COMPANY
1333 E. 179th Street · Cleveland, Ohio

Representatives

*LOS ANGELES, CALIF. J. W. Minder Chain & Gear Co., 927 Santa Fe Avenue.
*SAN FRANCISCO, CALIF. Adam-Hill Co., 244-246 Ninth Street.
INDIANAPOLIS, IND. A. R. Young, 518 North Delaware Street.
LOUISVILLE, KY. Alfred Halliday, 330 Starks Building.
DETROIT, MICH. George P. Coulter, 322 Curtiss Building.
MINNEAPOLIS, MINN. W. H. Erskine, Box 72, Traffic Station.
BUFFALO, N. Y. F. E. Allen, Inc., 2665 Main Street.
NEW YORK CITY, N. Y. Patron Millwright & Transmission Co., 154-156 Grand Street.
NEW YORK CITY, N. Y. E. G. Long Co., 50 Church Street.
GRAND RAPIDS, MICH. W. H. Slaughter, 419 Oakdale St., S. E.
NEW ENGLAND. George G. Pragst, 260 Esten Ave., Pawtucket, R. I.
PITTSBURGH, PA. Industrial Sales & Engineering Co., Box 8606, Wilkinsburg, Pa.
SALT LAKE CITY, UTAH. A. O. Gates, 619-629 South Fifth West Street.
*Stocks carried.

OHIO GEARS

Ivanhoe Road, Cleveland. Construction of the motors is such that all moving parts are completely enclosed. The housing is strong enough to withstand even an internal explosion without breaking. Rotors are integrally cast to insure reliability and uniformity of performance.

Transparent Plastics Have Many Uses

SEVERAL types of transparent phenolic molding materials have been developed by Bakelite Corp., 247 Park avenue, New York. Molded parts produced from these materials are extremely attractive due to their rich depth of color and transparency. Their properties include hardness, heat resistance, dielectric strength, dimensional stability and lightness in weight. In general the materials are extremely non-hygroscopic. There is little or no odor attached to them. Applications of this type of plastic material include automobile tail and dome light, lenses, signal indicators, traffic light panels, instrument housings, electric appliances, handles, etc.

Special Grease Fitting Developed

TO FACILITATE unusual lubricating conditions, the rubber-mounted ball bearing pillow block made by The Fafnir Bearing Co., New Britain, Conn., is now made with a grease fitting for difficult positions. The new pillow block has proved very satisfactory for air conditioning and ventilating equipment where the absence of noise is particularly desirable. Its molded rubber housing eliminates any slight bearing noise and compensates for partial misalignment or longitudinal shaft expansion.

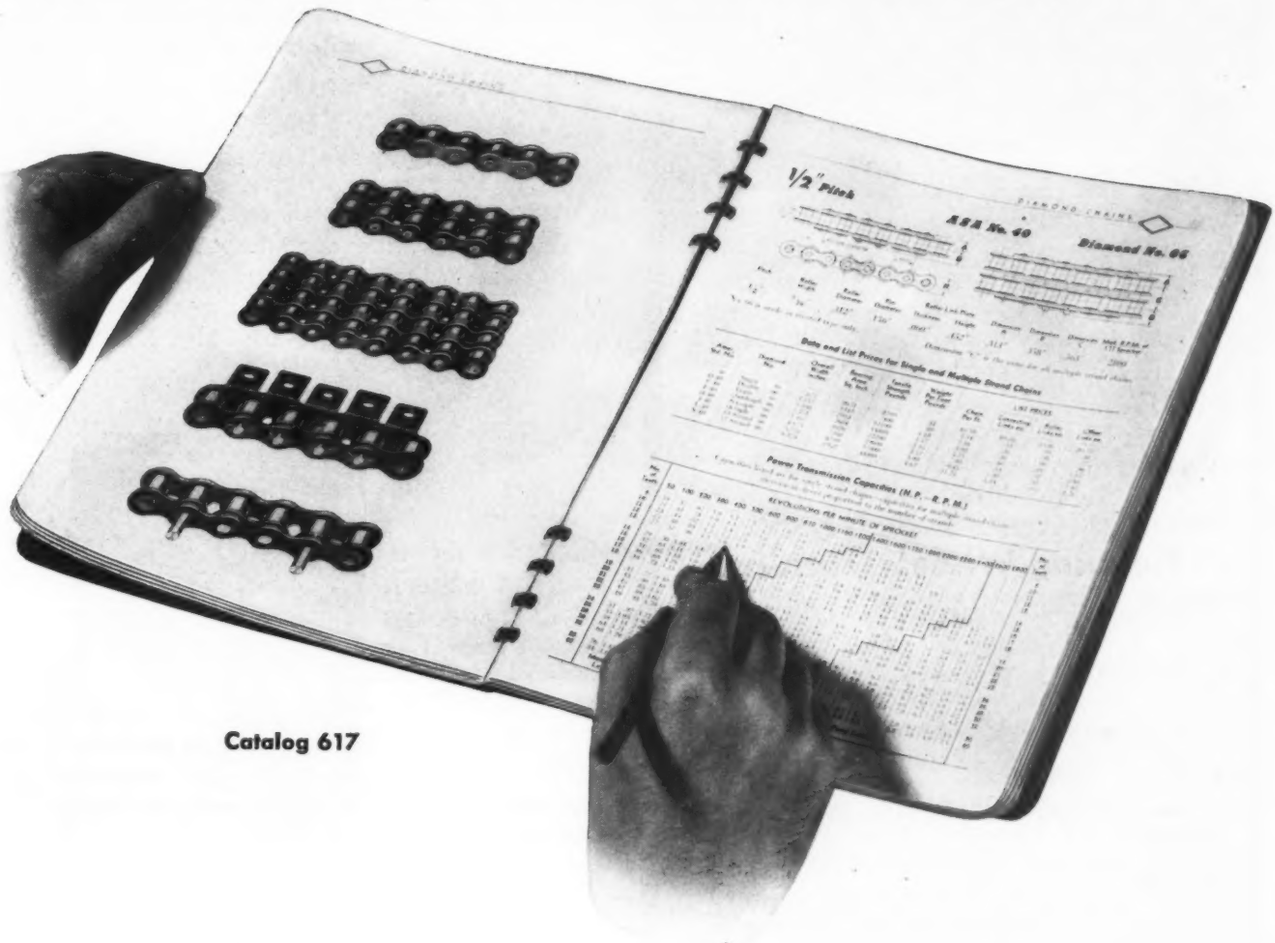
Control Station Line Announced

SUPPLANTING their existing line of heavy-duty control stations, a new line of Bulletin 800 stations, of the surface and flush mounting types, has been developed by Allen-Bradley Co., 1311 South First street, Milwaukee. These units have a maxi-

Pushbutton mechanism is of the unit type construction and can be mounted in combinations of one to ten buttons

A NEW BOOK-

FOR DESIGNERS AND BUYERS

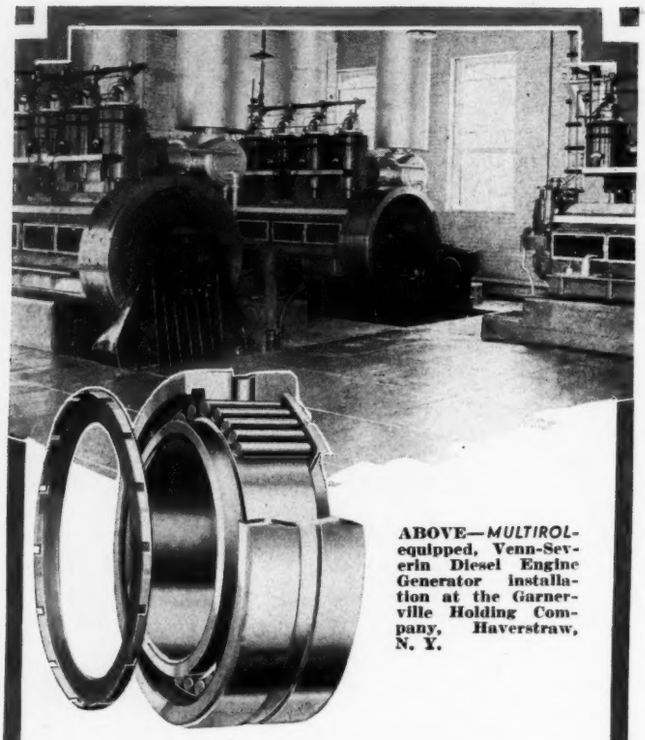

1/2" Pitch
ASA No. 40
Diamond No. 66
Data and List Prices for Single and Multiple Strand Chains
Power Transmission Capacities (H. P. - R. P. M.)

Catalog 617

● You will find—how to select modern higher efficiency power transmission chains for various speeds and capacities—how to select chains for machinery applications, and chains with attachments—also, full information on stainless steel and other corrosion-resistant chains—sprocket selection tables, etc.

This new Catalog 617 will give you the correct answers to your drive problems quickly. A copy will be mailed to you on request . . . DIAMOND CHAIN & MFG. CO., 435 Kentucky Ave., Indianapolis, Ind. *Offices and Distributors in Principal Cities.*

DIAMOND ROLLER CHAIN



ABOVE—*MULTIROL*-equipped, Venn-Severin Diesel Engine Generator installation at the Garnerville Holding Company, Haverstraw, N. Y.

Keeping Wheels Turning with

McGILL

MULTIROL

Precision Needle Bearings

Eliminate bearing troubles and replacements and you go a long way toward truly uninterrupted service, whether it be sewing machines, automobile engines or steam locomotives. McGILL *MULTIROL* Precision Bearings show finest records in these respects, have ever since they were introduced as the original needle type over eight years ago. Especially under sustained heavy or intermittent shock loads, their great load capacity in proportion to their overall size enables them to far outrun plain bearings and ordinary anti-friction types in many uses. Corrosion, heat resisting and other types gladly engineered to special requirements. Write for Bulletin No. 37 and list of stock sizes.

McGILL MANUFACTURING CO.

Bearing Division, 1450 N. Lafayette St.

VALPARAISO, IND.

mum direct current rating of 2.5 amperes, 115 volts; 1.25 amperes, 230 volts; .25 amperes, 550 volts and a maximum alternating current rating of 10 amperes, 110-220-440-550 volts. The pushbutton mechanism is of the unit type construction and can be mounted in combinations of one to ten buttons. These stations have attractive, black enameled, pressed steel enclosing box with multiple knockouts on top and bottom. The units are especially suitable for machine tool applications.

Timer Operation Simplified

SIMPLICITY of operation, easier setting of timing intervals by means of a knobbed dial, and positive quick make-and-break switch action are features of a new portable timer, No. 75M, announced by Walser Automatic Timer Co., Graybar Bldg., New York. In the new model, a standard timer is mounted into a molded black case with nickeled face plate and equipped with rubber covered cord and series wired plug. When the appliance is to be operated for any predetermined period the timer dial is pulled out and set for the interval desired. Attractive appearance and convenience of this portable timer make it especially suitable for timing household electrical devices and medical equipment as well as for use in the industrial field.

Standard timer is mounted in molded black case with nickeled faceplate

Pump Gives Variable Fluid Power

FINGER tip actuation of a small lever provides stepless variation of fluid power in the Type DH pump, developed by The Oilgear Co., Milwaukee, Wis. Movement of control lever through an angle of 50 degrees to either side of the neutral bypass or idle position increases the displacement automatically in proportion to the movement of the control lever. This simple control makes the type DH pumps especially suitable for operating straightening, as-

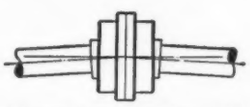
Now—A Flexible Coupling that's

The ONLY Coupling on the Market that Takes Care of ALL FOUR Drive Conditions Without Increasing Bearing Loads!

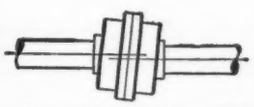
Here's a flexible coupling that's *more* than merely a coupling. Most couplings on the market take care of two or possibly three direct drive conditions and only when present to a *slight* degree. The RYBECK coupling is of full-floating, semi-universal joint design — *flexible in all directions.* It takes care of ALL FOUR drive conditions even when present to an *excessive* degree and without increasing bearing loads.

Why be satisfied with a coupling that only *partially* solves your direct drive problem when you can get a RYBECK full-floating coupling at no greater cost? Time-tested and manufactured by the T. L. Smith Company, a nationally known leader in its field for the past 37 years. Before you specify—investigate this better coupling. Write for bulletin.

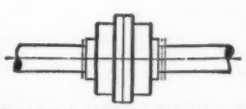
The T. L. SMITH CO., 2818 N. 32nd St., Milwaukee, Wis.

1 

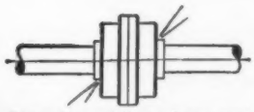
Allows for excessive ANGULAR misalignment of shafts.

2 

Allows for excessive OFFSET misalignment between shafts.

3 

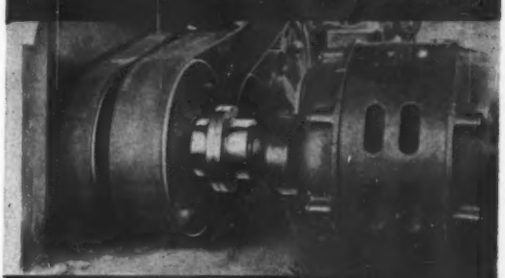
Permits END PLAY of shafts with minimum resistance.

4 

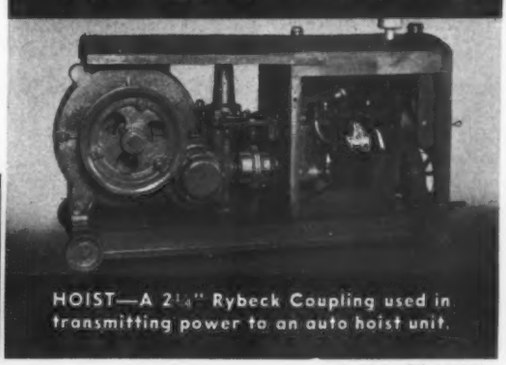
Absorbs and Smoothens out SHOCKS and Vibrations in the drive.

RYBECK
FLEXIBLE COUPLING

OIL DRILLER—5" Rybeck Coupling installed on 275 h.p. oil drilling rig in Olkahoma.

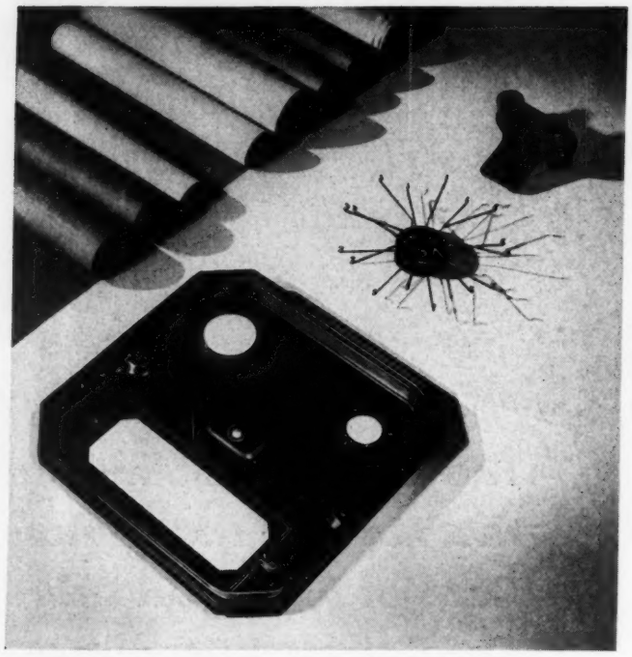


LUMBER MILL—Rybeck Coupling giving heavy duty service in a large midwest lumber mill.



HOIST—A 2 1/4" Rybeck Coupling used in transmitting power to an auto hoist unit.

A 2093-1PC (1037)



A Complete Service

From BLUEPRINT to DELIVERY

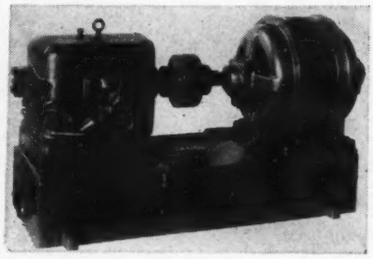
Whatever your molded plastic problem—whether it be electrical or mechanical parts, or a complete unit . . . Auburn Button Works is the place to send your plans or specifications. If necessary Auburn engineers will assist you in its design. If your blueprints are already drawn, you can be sure that the finished product will meet every specification, whether close electrical or mechanical tolerances, appearance, on time delivery or cost.

More than 60 years molding experience on orders of all sorts and types makes it possible for Auburn to meet every molding problem with the familiarity that breeds accuracy, precision and cost-cutting economy. When it's a molded plastic problem consult an Auburn engineer.

Established 1876

MOLDED PLASTICS DIVISION OF
AUBURN BUTTON WORKS, Inc.
AUBURN, N.Y.

sembling, forging, broaching and other general manufacturing presses, push and pull broaching machines,



Displacement of pump is easily changed by movement of control lever on side

rim rollers and the like. When used with hydraulic motor, the pumps constitute ideal variable speed transmissions.

Voltage Regulator Responds Quickly

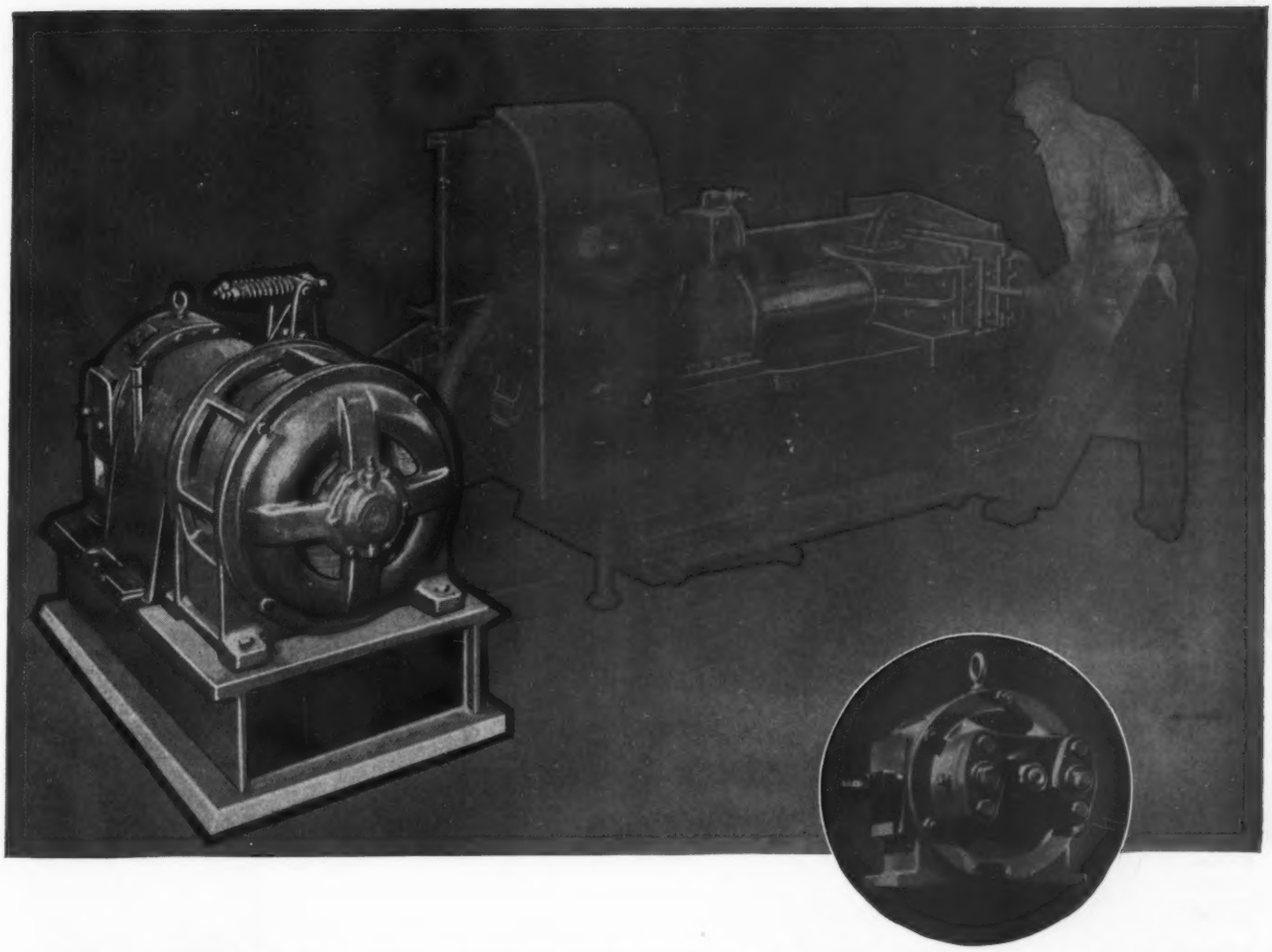
QUICK response to load changes is accomplished in a new type of vibrating voltage regulator announced by Ideal Commutator Dresser Co., 1442 Park avenue, Sycamore, Ill. Although designed primarily for the voltage control of alternating current gener-

No dash pots or other damping devices are used to retard regulator action

ators, the regulator is also suitable for most applications where the load varies suddenly and within wide limits. There are no dash pots or other damping devices to retard quick regulator action or require periodic maintenance. All live parts of the regulator are enclosed for safety and appearance.

Pump Has Right or Left-Hand Ports

NO RIGHT or left-hand ports need be specified in a new pump designed for truck mounting brought out by Viking Pump Co., Cedar Falls, Iowa. The unit is so constructed that the casing may be turned in the bracket which in turn rotates the pump openings making the pump truly universal. Another feature is the positive, sealed thrust bearing. No foreign matter



TO REDUCE ELECTRIC POWER COSTS CONSIDER FLUID POWER

A-E-CO Hele-Shaw Fluid Power Pumps reduce power costs. • Power from the prime mover can be conserved by applying to the pump a control which automatically adjusts the pressure required for increasing and decreasing work resistance. • Power in transmission is saved because gears, belts, and linkages are entirely eliminated. • Look into *all* the advantages of A-E-CO Hele-Shaw Fluid Power. It is reversible and variable. It is subject to the most precise control. It provides rapid and smooth adjustment of speed from zero to maximum. It makes remote control more practical. • Bulletin No. 1 will give you detailed information on the construction, sizes, capacities and uses of A-E-CO Hele-Shaw Fluid Power Pumps. Send for it.

American Engineering Company, 2502 Aramingo Ave., Phila., Pa.

A-E-CO HELE-SHAW FLUID POWER

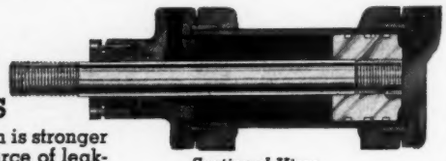
PUMPS, MOTORS, AND TRANSMISSIONS

A-E-CO Hele-Shaw PUMPS

AMERICAN ENGINEERING COMPANY

HYDRAULIC CYLINDERS
designed to match modern machine tool construction

This new type patented Hannifin high-pressure hydraulic cylinder provides every requirement for severe service and high efficiency hydraulic power. Strong, simple construction means ease of application, better appearance, and ready adaptability to a wide variety of uses.

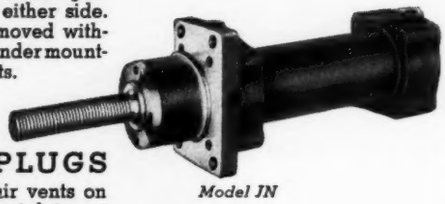


NO TIE RODS
This simplified design is stronger and eliminates a source of leakage. End caps may be removed without collapse of other parts of the assembly.

Sectional View

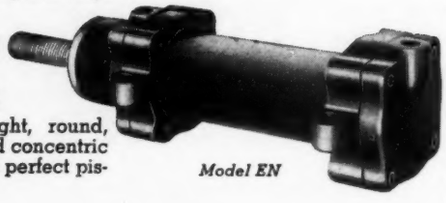
UNIVERSAL CAPS
Either end cap may be positioned, independently, so that inlet port is at top, bottom or either side. Either cap may be moved without disturbing the cylinder mounting or any other parts.

Model CN



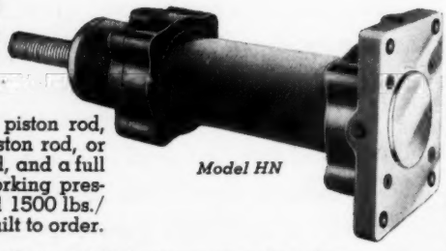
AIR VENT PLUGS
Each end cap has air vents on three sides. With the inlet port at either side or bottom there is always an air vent plug at the top.

Model JN



LEAK-PROOF
Special mirror finish honing produces a cylinder bore straight, round, perfectly smooth, and concentric with the end caps. A perfect piston seal is obtained.

Model EN



MANY TYPES AND SIZES
Hannifin Hydraulic Cylinders are offered in six mounting types, with small diameter piston rod, 2 to 1 differential piston rod, or double end piston rod, and a full range of sizes for working pressures up to 1000 and 1500 lbs./sq. in. Other types built to order.

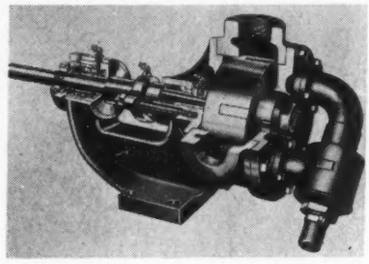
Model HN

Write for Bulletin 35-MD giving complete data.

HANNIFIN MANUFACTURING COMPANY
Engineers • Designers • Manufacturers
Pneumatic and Hydraulic Production Tool Equipment
621-631 SOUTH KOLMAR AVENUE CHICAGO, ILLINOIS

HANNIFIN
HYDRAULIC CYLINDERS

or water can enter the bearing to cause trouble. An enlarged stuffing box makes the unit still more leak resistant than former models. Pumps are available in capacities of 35, 50 and 90 gallons per minute.



Casing of pump may be turned in bracket which rotates pump openings, making right or left-hand port

Compactness Features Motor Starter

EXTREMELY compact, an across-the-line, alternating current starter has been announced by Cutler-Hammer Inc., 328 North 12th street, Milwaukee. It is used on polyphase squirrel-cage motors, and is ideal for innumerable applications, including fans, pumps, textile machinery, machine tools, etc.

Operating mechanism of the starter is rubber mounted giving quiet operation. It may be removed without disturbing conduit

This new starter measures 4¾ x 8 inches and is known as NEMA size 0. It is rated at two horsepower, 550 volts. Among the novel features are pushbutton operation, positive quick make-and-break "twin break" mechanism, silver to silver contacts, and rubber-mounted operating mechanism which is removable without disturbing the conduit. Case is small yet allows ample space for wiring.

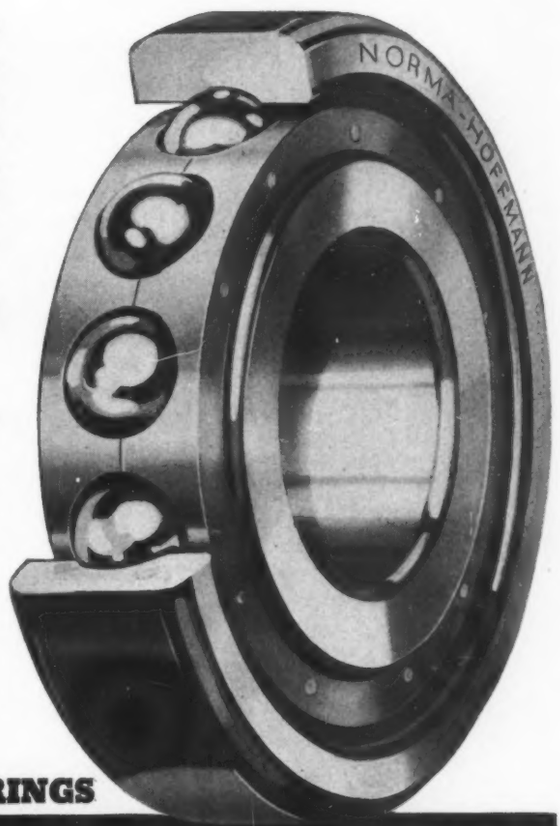
Corrosion Resistant Valves Offered

FOR severe service on small lines carrying steam, water, oil, gas and similar fluids, Crane Co., Chicago, offers a line of brass globe and angle valves with plug type disk of nickel alloy and body seat ring made of Exelloy, a specially heat treated chromium iron. This combination of metals is considered ideal for seating surfaces, having excellent re-

50,000 R.P.M.

in Daily Service

For over twenty-five years NORMA-HOFFMANN have been preeminently HIGH-SPEED PRECISION Bearings. They have long been operating successfully, in day-after-day duty, at speeds up to 50,000 R. P. M. Nor is this quality confined to one particular PRECISION type. Research has developed a "Super-Speed" PRECISION Bearing for every purpose.

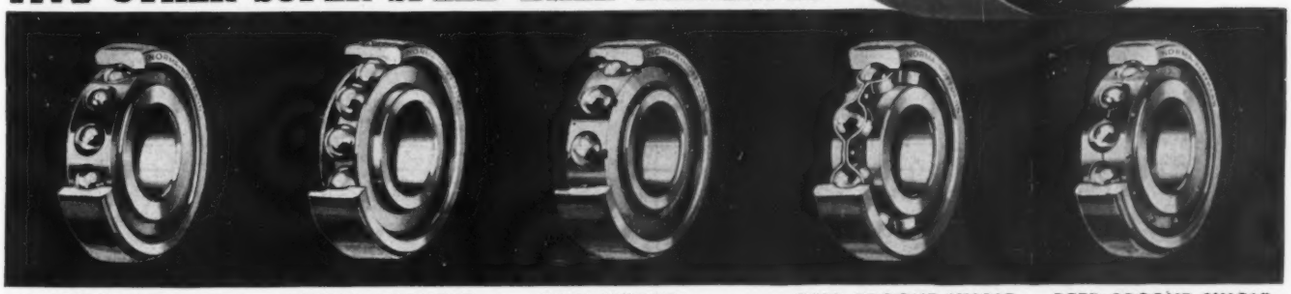


"LITRO" DEEP-GROOVE TYPE "CL"

For Thrust In Either Direction

This is the latest addition to the PRECISION "Super-Speed" line—a deep-groove type with uniform race shoulders, adapted to thrust in either direction. The lightweight, machined, balanced retainer is of specially-treated, hard, phenol-impregnated linen fabric, and rides on the ground shoulders (lands) of the inner ring. PRECISION in every minute detail adapts the "CL" Bearing to the highest speeds.

FIVE OTHER SUPER-SPEED BALL BEARINGS



LITRO "L" TYPE:—in both open (separable) and closed (side-assembled) types; machined, balanced, one-piece, land-riding, phenol-impregnated fabric retainer; adapted to thrust in one direction.

STANDARD OPEN TYPE:—a separable bearing with lightweight, one-piece, balanced, bronze retainer of channel section; for thrust in one direction only.

SUPRA "S" TYPE:—an open (separable) bearing with machined, balanced, one-piece, land-riding, bronze retainer, with oil grooves; for thrust in one direction.

DEEP-GROOVE SINGLE-ROW TYPE:—with special sturdy, pressed bronze ball retainer; adapted for thrust in either direction.

DEEP-GROOVE SINGLE-ROW TYPE:—with machined, balanced, solid, land-riding bronze retainer; adapted to thrust in either direction.

Write for Catalog

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PRECISION BEARINGS

BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.

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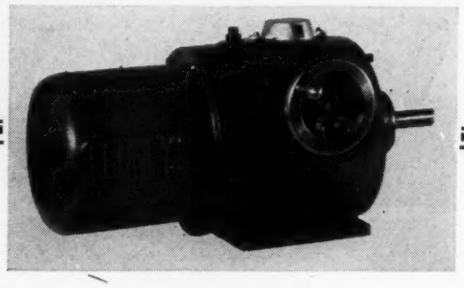
"Spring and Stamping Specialists for 35 Years"



Designed for

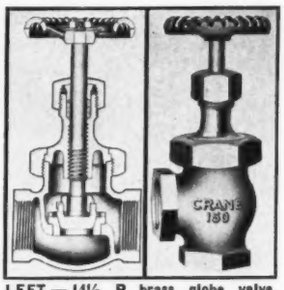
COMPACTNESS

One of the many notable features of the LENNEY Variable Speed Transmission is its Compactness. Importance of this characteristic was recognized at the start, resulting in a unit that is in keeping with modern design trends. A LENNEY drive meets every requirement both from an appearance and a mechanical standpoint. The built-in motor feature is outstanding because it utilizes the bearings in the transmission case, thereby facilitating compactness.

Write us for complete details. An informative illustrated catalog is yours for the asking.

THE LENNEY MACHINE & MFG. COMPANY
WARREN, OHIO

sistance to wear, temperature galling and scoring. Made in sizes ⅛ to 3 inches, these valves are recommended for 150 pounds per square inch steam working pressure and 300 pounds per square inch on cold water, oil or gas lines.

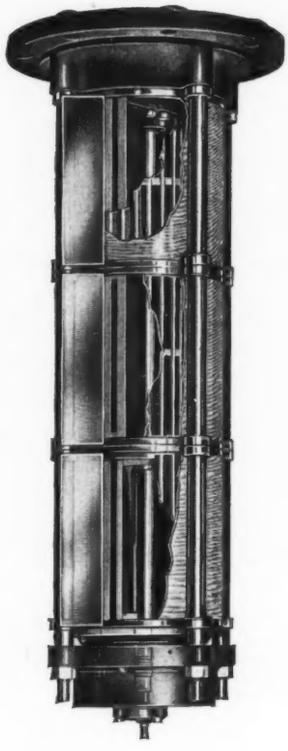


LEFT — 14½ P brass globe valve.
RIGHT — 16½ P brass angle valve.

Nickel alloy is used for plug type disk and body seat ring is made of Exelloy

Abrasive Solids Removed by Filter

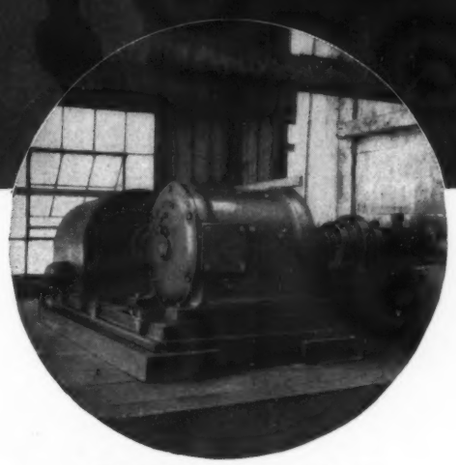
DESIGNED to remove solids from fluids where the solids are highly abrasive or fibrous and stringy, a self-cleaning filter of the backwash type known as Flo-Klean, has been announced by The Cuno Engineering Corp., Meriden, Conn. Pressure drop in the filter is low because the fluid in passing the filter medium moves in a straight line and meets only momentary restriction. Cleaning of the filter element is accomplished by slowly rotating the cartridge so that each portion of the filter surface encounters a momentary reversal of flow which dislodges the accumulated solids. This filter may be built with openings for the passage



Fluid in passing filter medium moves in straight line causing low pressure drop

On the Map!

D.O.-JAMES



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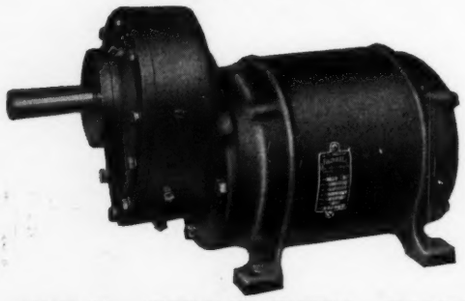

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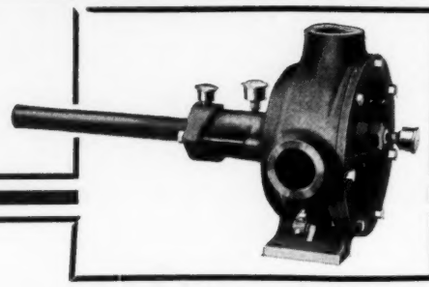

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If YOU are looking for a rotary pump, check these FACTS. First of all VIKING is built by the LARGEST exclusive rotary pump factory in the WORLD. It handles all clean liquids, regardless of viscosity—with suction lifts up to 20 feet. Discharges pressures up to 50 pounds per square inch.* It has been copied in design by more manufacturers than any other style . . and it is STILL first in the field. Stop looking . . start writing—get bulletins from Viking.

*Conservative limit—suitable for higher pressures on many applications.

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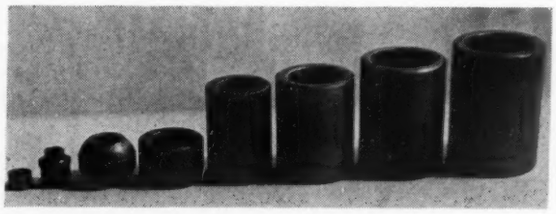
of fluid from .001 to .020 inch which covers a range of from 450 to 30 mesh screen.

Oilless Bearings Developed

COPPER and tin are the only metals used in a self-lubricating type of bearing brought out by Keystone Carbon Co., Bearing Division, Saint Marys, Pa. Porosity of the metal is about 32 per cent, allowing for a high oil content. Strength of 35,000 pounds per square inch is claimed for the bearings, permitting maximum loads. They will stand rough handling without distortion and there is small chance of breakage during installation.



Bearings will withstand rough handling without distortion and there is little chance of installation breakage

Engineering Department Equipment

Instrument Measures Vibration

DEVELOPED for measuring the amplitude of vibration of machine or structural members, the vibrometer is announced by American Instrument Co., 8013 Georgia avenue, Silver Spring, Md. Range of the instrument is from .001 to .030 inch amplitude. In use it is held in the hand and the needle point held against the vibrating part. Vibration of the spindle is transmitted directly to the Vibrometer pointer. The pointer appears double to the eye and the apparent intersection of the two images read on the scale in the background gives the amplitude of vibration in thousandths of an inch.

Vibrometer is held in hand and the needle point placed against vibrating part to take reading